THE

AMERICAN NATURALIST.

Vol. VIII.—DECEMBER, 1874.—No. 12.

IMBRICATIVE ÆSTIVATION.

BY A. P. MORGAN.

1. The arrangement of the different parts of the flower in the bud is called *æstivation* or *præfloration*. Æstivation has reference chiefly to the relative arrangement in the bud of the sepals and petals. The æstivation of the floral envelopes passes by several gradations from the regular alternate arrangement of leaves, in which the parts are situated at different heights one above another, to the complete whorled arrangement in which the parts are all placed at the same level, edge to edge.

2. There are distinguished three principal kinds of æstivation denominated respectively the *imbricative*, the *contortive* and the *valvular*. The latter presents no variety except the infolding of the edges of the leaves which, however, does not concern their relative arrangement in the bud; and contortive æstivation exhibits no variation except in the direction of the twist which may be either from left to right or from right to left. It is our purpose to give an analysis of imbricative æstivation and to endeavor to systematize its variability.

3. *In imbricative æstivation some parts of the floral whorl overlie others like shingles on a roof: that is, certain parts are wholly external while others are wholly internal.* There is usually a more or less evident spiral arrangement of the parts; the spiral making one or more turns to form the whorl. When the direction of the

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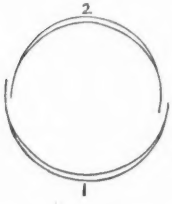
spiral in all the flowers of plants of the same kind is uniformly from left to right or with the hands of a watch, the parts of the whorl may be termed imbricate+; when the direction of the spiral is uniformly from right to left or contrary to the hands of a watch, the parts are imbricate—. If, however, the spiral does not maintain a uniform direction, but winds in some flowers of the plant to the right and in others to the left, the parts of the whorl may be termed imbricate ±.

Fig. 110.



4. Imbricative æstivation is the most common arrangement of both sepals and petals. It admits of much variety dependent upon the number and the relative position of the external and internal parts. Also, this variety of arrangement is displayed much more in the corolla than in the calyx.

5. In a dimerous imbricate whorl, the two edges of one part overlap both edges of the other part (Fig. 110), as in the calyx of the Spring Beauty (*Claytonia Caroliniana*). This is an alternate two-ranked arrangement.

6. In a trimerous imbricate whorl, one part is wholly external, one is wholly internal and the third is intermediate, that is, has

Fig. 111.

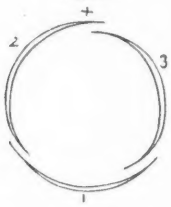
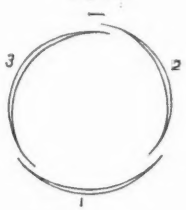


Fig. 112.



one edge in and the other edge out, as in the calyx and corolla of Trillium. Here there is an obvious spiral arrangement and the successive members of the cycle may be numbered 1, 2 and 3.

The spiral makes a single turn to the right or to the left according as 3 lies to the right or left of 1, and the whorl is imbricate+ (Fig. 111), or imbricate— (Fig. 112), accordingly. This is the 3-ranked or $\frac{1}{3}$ arrangement of leaves.

7. A tetramerous imbricate whorl presents two cases. In the

first case two opposite parts are wholly external, and the other two opposite parts are wholly internal (Fig. 113), as in the calyx of cruciferous flowers. This is the case of opposite decussate leaves. In the second case one part is external, one internal, and

Fig. 113.

Fig. 114.

Fig. 115.

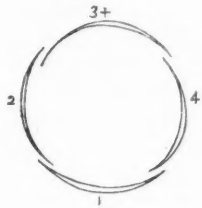
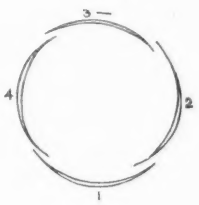


Fig. 116.



the other two intermediate. In this case there are two varieties, according as the internal part is opposite or adjacent to the external part. When the internal part is adjacent, there is an evident spiral arrangement. Numbering the parts 1, 2, 3 and 4,

Fig. 117.

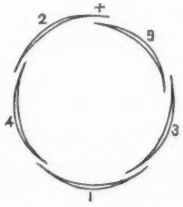
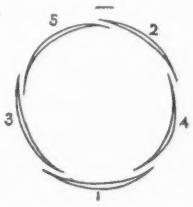


Fig. 118.



the spiral makes one turn to the right (Fig. 115), or to the left (Fig. 116), according as 4 is on the right or left of 1. This is the common arrangement of the petals of cruciferous flowers. The internal part may sometimes be seen opposite (Fig. 114) in

the same flowers; this is the arrangement of the four sepals of the White Water Lily (*Nymphæa odorata*).

8. A pentamerous imbricate whorl, also, presents two cases.

I. Two parts of the floral whorl are external, two parts are internal and one is intermediate (Figs. 117, 118). This is regular pentamerous imbrication. It corresponds to the quincuncial or $\frac{2}{5}$ arrangement of leaves. The spiral makes two turns to form the whorl. The successive members of the cycle may be numbered 1, 2, 3, 4 and 5 (Figs. 117, 118). 1 and 2 are the external parts; 4 and 5 are the internal parts; and 3 is the intermediate part. 1 has 3 and 4 adjacent and 2 and 5 opposite. One edge of 3 is covered by the adjacent edge of 1, while the other edge of 3 overlaps the adjacent edge of 5. The succession of the numbers of the cycle in the whorl, in one direction, is 1, 4, 2, 5, 3; in the other direction, 1, 3, 5, 2, 4. 3 shows the direction of the spiral; when it lies on the right of 1, the spiral winds from left to right, and the parts of the whorl are imbricate + (Fig. 117); when it lies on the left of 1, the spiral winds from right to left, and the parts are imbricate — (Fig. 118).

II. One part of the floral whorl is external, one part is internal and three parts are intermediate. This is irregular pentamerous imbrication. There are two varieties of this case, according as the internal part is opposite or adjacent to the external part.

Fig. 119.

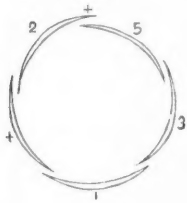
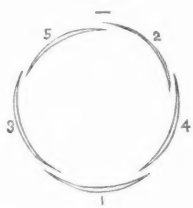


Fig. 120.



When the internal part is opposite (Figs. 119, 120) there is still a spiral cycle of two turns; but the part 4 by a slight torsion, throws out one edge over the adjacent edge of 2; so that 2 and and 4 have one edge out and one edge in, the same as 3: 3 lying between 1 and 5 still shows the direction of the spiral. This is the æstivation of papilionaceous flowers. In these the large petal called the vexillum or banner overlaps the others, and on this ac-

count this variety has been termed *vexillary* imbrication. This variety of imbrication, however, occurs frequently in the flowers of many plants along with the regular imbrication, as shown in the examples of *Rubus odoratus* and *Pyrola elliptica* (Tables I and II). When the internal part is adjacent to the external part

Fig. 121.

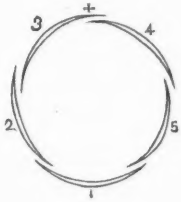
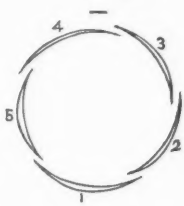


Fig. 122.



(Figs. 121, 122), the spiral makes but a single turn to form the whorl. The direction of the spiral is shown by 5 lying on the right or on the left of 1. This second variety is perhaps to be met with only as a casual variation from the other modes. I know of no flowers in which it is the only mode of æstivation, but the extent to which it occurs in many flowers is shown by the example of *Rubus odoratus* (Table I).

Fig. 123.

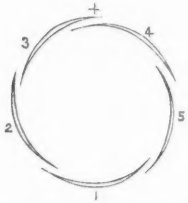
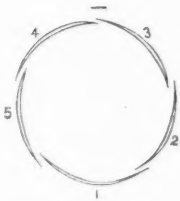


Fig. 124.



9. The second variety of irregular imbrication passes easily into contortive æstivation by 5 throwing out one edge over 1. This also is shown by some of the flowers of *Rubus odoratus* passing into the contorted mode.

10. The imbrication of the flower sometimes shows a fixed relation to the axis, and whether there be such a relation or not, needs to be carefully observed. When the inflorescence is definite the flower terminates the axis and of course there is no other relation. Hence the position of the external and internal parts is

immaterial in diagram. When the inflorescence is indefinite, however, the external petal sometimes maintains a fixed relation to the axis. For instance, in papilionaceous flowers, the external petal is always the posterior one. In the violet the external petal may be either the right or left upper petal, the lower spurred petal being always internal. In many plants on the contrary, some of the flowers commence the spiral at one part of the whorl, and other flowers at other parts of the whorl. This is shown by the example of *Pyrola elliptica* (Table II.)

11. For the purpose of observing and recording the mode of imbrication in a pentamerous flower for example, rule a table as follows (Table I):

In the Table, I denotes the first case or regular imbrication; II denotes the second case or irregular imbrication; while 1 and 2 indicate the first and second variety of II. Each example is marked by the direction of the spiral. Summing up the observations of 100 flowers of *Rubus odoratus*, examined for the illustration of this article, they show the following variety of arrangement:

Calyx, imbricate.
Case I. + 54, — 46. Total, 100.
Corolla, imbricate.
Case I. + 22, — 10. Total, 32.
Case II.
1 v. + 14, — 13. Total, 27.
2 v. + 20, — 13. Total, 33.
Corolla, contorted,
+ 4, — 4. Total, 8.
Total + 60, — 40.

TABLE I.

Rubus odoratus L.

No. of Spec.	Calyx, imbricate.			Corolla, imbricate.		
	I	II		I	II	
		1	2		1	2
1	−				+	
2	−					+
3	+				−	
4	−				−	
5	+			−		
6	+					−
7	+				+	
8	+			+		
9	+				−	
10	+					+
11	−					+
12	−				+	
13	−				−	
14	+			+		
15	+					−

[*TABLE II.*] CASE I.

No.	1	2	3	4	5
3	l	p′	a	p	l′
12	l	l′	p	a	p′
18	l′	l	p′	a	p
4	l′	p	a	p′	l
16	p	l′	l	p′	a
2	p	a	p′	l	l′
3	p′	a	p	l′	l
3	p′	l	l′	p	a
10	a	p	l′	l	p′

CASE II. 1.

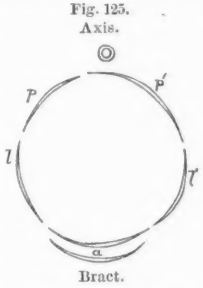
4	l	l′	p	a	p′
1	l	p′	a	p	l′
5	l′	p	a	p′	l
1	p	l	l′	p	a
2	p	a	p′	l	l′
2	p′	l	l′	p	a
2	p′	a	p	l′	l
5	a	p′	l	l′	p

CASE II. 2.

3	l′	p′	p	l	a
3	l	a	l′	p′	p
1	a	l′	p′	p	l

12. For the purpose of observing and recording both the imbrication of the whorl and the relation of its parts to the axis, I make a diagram of the flower (Fig. 125) and rule a table as on the opposite page (Table II):

Fig. 125.



In this diagram of the corolla of *Pyrola elliptica* (Fig. 125) p and p' denote the upper or posterior petals; l and l' the lateral petal; and a, the anterior or lower petal.

In Table II the figures 1, 2, 3, 4, 5 represent the successive parts of the spiral. The Table shows the summing up of one hundred observations of the imbrication of the corolla of *Pyrola elliptica* Nutt.

THE METAMORPHOSIS OF FLIES.* III.

BY DR. AUGUST WEISSMANN.

WHAT appears most unusual in the development of the Muscidæ is the genesis of the thorax and head together with their appendages. That this section of the fly's body is completely formed anew, not standing in genetic connection with the corresponding parts of the larva, contradicts the generally accepted and long prevalent view, according to which pupation is only a moulting process. As little does this opinion agree with the fact of the total transformation which all the inner organs suffer during pupation. All the systems of the organs of the larva die, in part completely, in part cell by cell, in order afterwards to be built up anew.

Evidently the metamorphosis of Corethra stands in diametrical opposition to this mode of development, and indeed to the two previously described main points. Here the pupation may be rightly regarded as a moulting process; we see no phenomena ac-

*Being the concluding chapter of "Die Metamorphose der *Corethra plumicornis*, ein weiterer Beitrag zur Entwicklungsgeschichte der Insecten. Von Dr. August Weissmann. Mit. 5 Kupfertafeln. Leipzig, 1866. 8vo, pp. 83.

companying the process, which cannot be brought under this head. The nature of the moulting process I see in this, that the layer of cells, which we regard as the hypodermis, and which appears as a skin split apart from the chitinous skin, after certain changes of form, develops a new chitinous skin, and that this takes place without any solution of continuity of the same. The change of form may arise merely through simple growth, accompanied by a more or less considerable remodelling; or it may be due to the formation of new, or to the disappearance of parts already present. The latter occurs through shrinkage, the former to a growing out of the hypodermis. It is the hypodermis which generally imparts to the insect its form, from which the formation of the appendages of the segments proceeds, the typical as well as the accessory.

The mere remodelling of the parts of the body already present we saw fully illustrated in the Corethra larva; thus the head gradually takes on a different form, the mandibles, in the young larva beset with long, slender bristles, afterward become thick, massive, raptorial jaws, with sharp teeth, etc. But most instructive are these relations in the antennæ, where indeed a less change of form, rather than a considerable increase in size may be noticed at each moult. This is accompanied, as we have seen, by a complete pushing inwards of the hypodermis, whereby is afforded in the only possible way an important space for the increase in size. After the splitting off of the old chitinous skin the stretched hypodermis-layer again turns back throughout its length and breadth. No more direct proof can be given for the correctness of the view which regards the appendages of the segments of Arthropods as protrusions of the skin.

This occurrence is only important as being a preliminary stage for the rise of the antennæ of the imago; still this arises through a simple, though still deep-reaching remodelling of the larval antennæ, and thus stands in relation with the other typical cephalic appendages. No enlargement of the parts takes place, indeed the hypodermis is simply loosened and models itself anew, for the most part during a perceptible decrease in size, into the antennæ of the imago; so for example the mandibles. But should, on the contrary, an enlargement take place, as in the under lip, then this arises through a pushing up of the hypodermis from the bottom of a falling-in of the body wall, and here the difference in size and form between the new and old organs is so considerable, that

we can rightly indeed regard it as a new formation; the passage to the real new formation is here indicated, and we finally see also the appendages of the thorax, which in the larva are completely wanting, certainly developing in the same manner; the simple growth of the antennæ at each moulting of the larva, the formation of the fly's beak out of the under lip of the larva, and the outgrowth of wings and limbs at places in the hypodermis previously wanting them, are also only modifications of one and the same occurrence; the protrusion of the hypodermis.

So far it certainly appears legitimate to regard the formation of Corethra as a moulting process. The entire hypodermal skin it is which remodels itself, in part shortening, in part elongating and drawn out, but which never loses its continuity.

But this does happen in the Muscidæ. The hypodermis of the anterior larval segments must die, in order that the imaginal disks lying within the body cavity on the upper surface, and a new thorax and head may be composed; evidently a phenomenon which exceeds the idea of a moulting. It is a mistake to exceed known facts. It were a greater error to conclude from the fact that the imaginal disks of the Muscidæ are already formed in the embryo, that the body of the imago was already formed, as in Corethra, in which the wings and limbs begin to grow after the last moulting. The imaginal disks of Musca are not simply rudiments of the appendages of the segments, but really *the segment itself;* but in Corethra the germs of the segments of the imago are already present in the egg, not alone in the form of isolated disks, but as the complete segments of the larva, which afterwards give rise to the appendages, in order to build up the segments of the body of the adult insect. The body of the imago is also on the contrary more perfectly formed in the larva of Corethra.

It is by no means surprising that the appendages of the segments of Corethra begin to develop after the last moult of the larva. Should they arise earlier, then they would already appear during the life of the larva as external parts, the chitinous skin which in the process of moulting would separate anew would press to the half-formed appendages, and the larva would thus be no more a larva, the metamorphosis no more complete, but an incomplete one. A development of the appendages beginning *before* the last moulting would, in a metabolic insect with the mode of development of Corethra, be only conceivable if the same previ-

ously originated not as a direct protrusion, but as an invagination, also forming no projection on the upper surface of the hypodermis, as in fact seems to be the case in the wings of Lepidoptera.

But we will take a nearer glance at the mode in which the formation of the appendages and especially those of the thorax takes place. Many differences between Musca and Corethra appear, and also many resemblances, and indeed in points of great importance, so that we must say *that the formation of the thoracic appendages goes on in the two insects in essentially the same way, and indeed the process of formation may be considered as simply local protrusions of a broad, flat, basal membrane.* This basal membrane is in both cases the hypodermis of the thorax, which in Corethra at the time of formation of the appendages at once arises as a whole, while in Musca it exists only in a rudimentary way in the form of many pieces separated from one another. Ideally in fact the thorax of Corethra consists of twelve such pieces, each one of which is destined to grow out as an appendage. Only an apparent similarity lies in the relation which exists in the two Diptera between the nerves and the newly forming appendages. In Corethra all the appendages of the thorax, with the exception of the gills around the end of the body are provided with sensible (*sensibeln*) nerves; for then with their increasing growth the nerve-stalk will be surrounded. From the neurilemma of these nerves arises the formation of the tissues filling the cavity of the appendages; they form a store of cells (*zellzucherungen*) which are transformed into the tracheæ, muscles, sinews and nerves of the appendages. Only in the origin of the gills, the place of the nerve is supplied by a trachea, which in those organs wanting nerves and muscles certainly play the same part as the nerve.

The imaginal disks of the Muscidæ also stand in connection with the nerves, but the significance of this fact in regard to the development of the appendages is still quite another thing. This is due to the fact that not *all* the disks are attached to nerve-filaments, *as indeed are not all those from which originate similar appendages.* The imaginal disks of the two anterior limbs are attached to nerves; the hinder spring up from the tracheal stems without any connection with nerves. The conclusion is inevitable that the nerve-stems are here nothing else than points of attachment for the new formations. Certainly it is evident that the nerve passes through the new formation in order to reach the

organ lying next to the skin (ganglion or muscle); still this is accomplished in quite a different way from the Tipulidæ, where the cavity of the appendages is traversed longitudinally by a nerve (at least in the legs), while in Musca the appendage is in fact wholly free from nerves, at all events with none of its primitive fibres present, and at best may be traversed by such as are formed anew during the outgrowth of the appendages. At all events the new formation of the tissues filling the cavity do not proceed from the neurilemma, but from the nuclei arising from the destruction of the fat body.

But still in the manner and mode, in which the growing limb pushes out, there is no inconsiderable difference.

In Corethra there is at first a completely unjointed cylindrical skin which lies wound up in a spiral on the piece of the thorax belonging to it; as soon as the new formation has evidently grown in length, when the differentiation of the cell-masses of the cavity into tissues has advanced, the first traces of joints appear.

Quite otherwise in Musca, where the segmentation begins at an early period and is complete along the whole length of the projecting appendage. Even before the growth outwards of the limb ever projects up prominently above the level of the basal membrane, the end of the limb (the fifth tarsal joint), is separated from the basal membrane; then with the elongation of the tarsal spines, the four other tarsal joints become interpolated, while the tibia and fibula still form an unjointed portion, whose complete division into the joints of the fly's limbs occurs after the formation of the thorax. During the whole development within the disk the limb still remains as a short projection which, without turning, stands straight up over its thoracic piece. As soon as the new thorax is formed, it begins to grow moderately, and considerably later, in the second half of the pupal sleep, the muscles and other tissues arise in the cavity of the appendages, and finally the limb assumes its external, definite form. From the last mentioned facts, it clearly appears that with the existence of imaginal disks, which the muscid larva brings with it out of the egg, no greater preparation in fact is made for building up the body of the imago; that here a much more marked transformation must be undergone. When Corethra transforms into a pupa, the muscles of the wings and limbs are already formed, while in Musca there is not yet the first trace to be seen of either; the mouth parts undergo in Co-

rethra only a final modelling, while in Musca the head does not yet appear as a whole, and nothing of the beak is yet formed.

But if in relation to the external form and formation of the tissues in the interior the Corethra larva stands nearer its imago, so not less as regards the systems of internal organs. Here also we find a complete continuity between larva and pupa; no new organs arise in place of the old, but the old either remains the same, or are wholly intact, or with only slight changes, as are required for the changed mode of life of the animal; thus the dorsal vessel passes wholly unchanged over into the fly, and except the slight shortening of the œsophageal ring, the nervous system also. Other organs are completed through increase in size in some, through concentration and disappearance in other places, as for example in the digestive canal, and the sexual organs which had long previous been completely formed. Only parts which are single become entirely superfluous and disappear and never arrive at a complete, new structure, independent of the systems of organs already present.

It is wholly otherwise in Musca, where all the systems of organs of the larva disappear, and are formed anew from new building materials, whether they return to molecules, which mingle with the blood, as the hypodermis of the anterior larval segments, as all the larval muscles, many of the tracheæ, the anterior part of the digestive canal; or whether they pass through that interesting process which I have termed *histolysis*, and whose nature consists in a destruction of the histological elements, without giving up the general form of the organ, and in a succeeding new formation from the ruins of the tissues.

But most remarkable and pregnant is the difference in the processes of growth within the body of the pupa, since in Corethra the fat bodies play throughout a very subordinate and scarcely perceptible part, while in the Muscidæ a building up of the inner organs without the intervention of this important part of the body were not possible. There is need only for the colossal mass of the fat body in the muscid larva; and seeing the thick whitish pap-like substance, with the product due to its destruction filling the body-cavity of the pupa, we can estimate the true significance of the fat body in the development of the Muscidæ. And it would appear that the fat body in these insects is not only a depot of nutritive material, but that out of the products arising from its destruction,

entirely new histological form-elements arise: the masses of nuclei which fill the body-cavity of the pupa with a compact mass, whose brood of cells, multiplying through endogenesis, arrange themselves into strings and thus form the primitive germs of the tracheæ and in fact the muscles.

Indeed it is difficult to tell out of what material the muscles of the wings of the Muscidæ should arise, if not out of the descendants of the masses of nuclei. But in Corethra we find the corresponding muscles already indicated in the embryo in the form of fine filaments; but how could this be the case in the Muscidæ, where the points of attachment of such filaments, the hypodermis of the thorax, are not yet present in the larva? And the same conclusion follows in regard to the tracheal system of the imago, which in Corethra is indicated beforehand, the entire division of the body of the imago answering to the corresponding segments of the larva—which in Musca can only arise when these regions are formed, *i. e.*, in the course of the pupal life.

Thus in every relation a much less morphological connection exists between larva and imago in the Muscids, than in the Tipulids, and in this fact is to be sought the reason for the relation of the duration of larval life to the long pupal stage.*

In Sarcophaga it requires eighteen days from the pupation to the exclusion of the fly, in Corethra only three. However, on the other hand the life of the larva of Sarcophaga lasts only eight days, in Corethra three or more weeks, and this difference cannot alone be referred to the wholly opposite mode of nourishment of the two larvæ, which makes it possible in the Musca larva to suffer a great mass of food to pass in a few days through its intestine, while the Corethra living by robbery only slowly procures food. The evidence lies in the very long interval, which separates the last moulting of the larva from the pupation in Corethra. It is surely not unimportant or adventitious, but will be met with in cases where the origination and completion of the appendages of the imago must take place within this period.

The pupa of Corethra manifestly differs in morphological as

* Evidently it is only the relative, not the absolute duration of the pupa-stage, which is here considered. This may vary in one and the same species between wide limits; for example the pupa-stage of Corethra lasts only three days in midsummer; in March the same lasts eight days. But also the corresponding life of the larva is longer in such March pupæ, the larvæ having wintered over from the preceding autumn. In the Muscidæ on the contrary, the pupa winters over.

well as physiological relations from the pupa of the Muscidæ; it does not *become* the imago, but it *is* nothing else from the start, and undergoes only a slight completion, in order to slip out from the pupa-skin as a winged and sexually mature insect. A pupa-sleep in the true sense it thus completely lacks, all functions of animal life in the pupa go on uninterruptedly, only the act of taking food ceases. All the occurrences which fill out the interval of latent life in Musca, during which the blood no more circulates, every sensation and movement, as well as the taking of food—every act which may go under the head of "formation of the pupa" fall in Corethra into the larval period, and the pupal stage is to be compared with the two last days of the Muscid pupa; when still in this respect the almost fully formed insect stands near its final perfection, since it, if artificially freed from its tun-shaped case, is more or less movable and lively.

Finally, we may distinguish two diametrically opposed forms of insect metamorphosis; the one represented by Corethra stands nearest to development without metamorphosis; the other represented by Musca is farthest removed from the ametabolic development and is the most extreme form of metamorphosis. Expressed in a very general way, the difference between the two consists in this, that at one time a *continuous*, at another a *discontinuous development* occurs, in the sense, namely, that the parts of the body and organs of one stage of development originate directly from the similar parts of the foregoing stage; or if such is not the case, rather the parts of the body and internal organs of the later stages of development are substantially new formations.

We may briefly characterize the two modes somewhat thus:—

Type Corethra. *The larval segments are converted directly into the corresponding divisions of the imago; the appendages of the head into the corresponding ones of the head of the imago; those of the thorax arise after the last moult of the larva, as outgrowths of the hypodermis around a nerve or trachea, from the cellular envelope of which the formation of tissue in the interior of the appendages issues. The larval muscles of the abdominal segments are transferred unchanged, into the imago; the thoracic muscles peculiar to the imago, as also some additional abdominal muscles, are developed in the last larval period from indifferent cellular filaments which are indicated even in the egg. The genital glands date back to the embryo, and are gradually developed; all the other systems of organs*

pass with little or no alteration into the imago. Fatty body none or inconsiderable. Pupa state short and active.

Type Musca. *Thorax and head of the imago arising independently from the corresponding divisions of the hypodermis of the larva; only the abdomen directly through the transformation of the eight hinder larval segments. Thorax and head with their appendages develop from imaginal disks, which are of embryonal origin and are attached within the cavity of the body to nerves or tracheæ. Immediately after the formation of a tun-shaped pupa case from the chitinous skeleton of the larva, the imaginal disks grow together into the thorax and head. Destruction of all the systems of larval organs, either total or through histolysis. New formation of the same by means of the masses of nuclei arising out of the destruction of the fatty body. Genital glands indicated in the embryo have a continuous further development. Pupa state lasting for a long time and with a latent life.*

The two types are most sharply distinguished from each other by the presence or absence of true imaginal disks, and I might for this reason suggest dividing those insects having a metamorphosis into *Insecta discota* and *adiscota*.*

A subsequent memoir remains to be prepared, in which an effective division is to be made showing what families belong to one and what to the other group. It may be here previously observed, that the two groups do not stand completely opposed, without transitions, but that there are intermediate forms; indeed whole families, perhaps whole orders of insects may on account of the want of imaginal disks be regarded as *Insecta adiscota*, while their development in other respects may closely join them to the *discota*.

*The italics in this translation are the author's.

ON THE COTTON WORM OF THE SOUTHERN STATES (Aletia argillacea Hubner).

BY AUG. R. GROTE.

The earliest* scientific name for the cotton worm is given by Jacob Hübner in the second hundred of his "Supplement to the Collection of Exotic Lepidoptera," dated 1822. The moth is there figured in two positions under the numbers 399 and 400, and described under the name *Aletia argillacea* on page 32. Although the insect has subsequently received different names, this name of Hübner's is the one it should in future bear. For the name "*Anomis xylina*," now in scientific use, I am responsible. In the year 1864, in the Proceedings of the Entomological Society of Philadelphia, I referred the *Noctua xylina* of Thomas Say to Hübner's genus Anomis, as defined by M. Guenée, and regarded as synonymous the *Anomis bipunctina* of the latter author.

With the true type of the genus Anomis, the *Anomis erosa* of Hübner, I have since then become familiar, and I find that it differs structurally and generically from the cotton worm moth, which latter must accordingly remain under the combined title originally proposed for it by Hübner.

The different stages of Aletia, as it is found throughout the cotton belt of the Southern States, have been faithfully portrayed by Professor Townend Glover, of the Agricultural Department in Washington. On the Professor's plates numerous other insect depredators on the cotton plant are excellently portrayed, and this work (I believe as yet unpublished) ought certainly to be issued by the Legislatures of the different states interested in cotton culture, or indeed by the General Government, and publicly distributed, so that a knowledge of the economy of these parasites be diffused. For his manuscript work, Professor Glover has indeed received a medal from the late Emperor of the French (a nation fortunately profuse in acknowledgment) but, if I am correctly informed, no more substantial reward has as yet crowned Professor Glover's

*I am indebted to Dr. Hagen for the bibliography of the *Noctua gossypii* of Fabricius. I believe this to be a distinct species from the *Aletia* and probably belonging to a different family.

praiseworthy efforts for the advancement of knowledge and the consequent amelioration of his race.

In the Second Report on the Insects of Missouri, Professor C. V. Riley notices the cotton worm, and illustrates the moth by a woodcut, in which the insect is represented head downward in a state of rest. The moth is drawn in this position on the authority of a gentleman in Texas, and the subject is treated throughout, and indeed necessarily, by Professor Riley, at second-hand. In Professor Riley's Sixth Report (published this year) the cotton worm is again discussed under similar conditions, while the position of the moth in a state of rest has now become normal. It is however claimed, in this Report, that the cotton worm "hibernates" as a moth, and the credit of this observation is given to the Second Report, while the discovery of the fact is claimed to have been made by what Professor Riley calls the process of "analogy."

It is the object of the present paper to throw, happily, some light on the biography of the cotton worm as it occurs in the Southern States, and in so doing I think it will become apparent that Professor C. V. Riley has regarded the same subject from an erroneous standpoint, having considered the cotton worm as belonging to our fauna, and accordingly misunderstood its economy as displayed with us and far from its natural abode. And here, while I am obliged to differ on a scientific question with Prof. Riley, I bear willing testimony to the great good achieved by the publication of the Missouri Reports.

The *Aletia argillacea*, or cotton worm, is an insect belonging to the Noctuæ, a group of nocturnal moths. It is one of a number of intertropical or southern forms, somewhat nearly allied to our more thickly scaled and northern genus Plusia. The caterpillar is a "half-looper," to use a common term, and the chrysalis is held within an exceedingly loose web on the plant, the few threads usually binding over the edge of the leaf and of themselves furnishing no adequate protection to the pupa. [I here exhibit to the Association specimens of the larva, pupa and moth of Aletia]. Technical descriptions of the different stages are already extant and so may be passed over here. The more immediate question for our solution is the consecutive history of the insect, so that we may be prepared to offer suggestions to the agriculturists for its destruction.

The region over which, during five seasons, I have observed the cotton worm, embraces the central portion of the cotton belt in the states of Georgia and Alabama, and in particular the counties of Marengo and Greene, lying along the Tombigbee and Black Warrior rivers. There cotton is planted in March and April, blooms in June and July, and perishes in November or with the frost. The earliest period at which I have noticed the young worm was the last week in June, and its usual appearance was in July, sometimes as late as the latter part of the month. Its date of appearance was irregular, and never accurately coincided in any two seasons. Sometimes it seemed as though we were "*not going to have any worm at all this year*," a remark suggested by hope and the tardiness of its advent. My observations have been mainly directed to the question of the origination of the first brood and have led me to record the following results. I have observed that the appearance of the worm in the fields was always heralded by flights of the moth, which came to light in houses at least a week before the worm was noticed on the plants. I have observed that the distribution of the first brood was irregular; the worms occurring here and there over miles of country, while infesting some plantations, skipping unaccountably others which the second brood, however, seldom failed to reach. I have noted that the worm was always heard of to the southward at first, and never to the northward, of any given locality in the cotton belt. Finally, after diligent search, no traces of the insect in any stage could be found by me during the months *preceding* the appearance of the first brood heralded by the moth, and *after* the cotton was above the ground. The broods themselves were consecutive and without interruption so long as the conditions were favorable. The last brood, in years where the worm was numerous, eat up every portion of the plant that was at all soft, flowers, the persistent calyx, the very young boll, the terminal shoots. The last brood of worms changed into chrysalides in myriads on the leafless stems, clinging by their few threads as best they might, and disclosed the moth in the face of the frost, many of the chrysalides perishing. Afterwards, on sunny winter days, I have noticed the live moth about gin houses and fodder stacks, or the negro quarters. Was this a true "hibernation" or merely an accidental survival? The locality and the condition seem to me alike artificial.

Now Hübner describes the moth of the cotton worm at first, as

from Bahia. Sufficient testimony to the identity of our insect with one destructive to the West Indian, Mexican and Brazilian perennial cotton, is at hand and the fact is established. In a classificatory point of view, the affinities of the cotton worm are with southern rather than northern forms of its family, as I have already pointed out. The conclusion to which I have come with regard to the cotton worm is, *that it dies out every year* (*with its food plant*) *that it occurs in the cotton belt of the Southern States, and that its next appearance is the result of immigration.* Testimony is at hand to show that for many years after the cultivation of the cotton plant was introduced into the Southern States, the cotton worm never appeared. The date at which it first appeared in Central Alabama has been differently stated to me, but it evidently but little preceded the late war. That the moth is capable of sustaining long and extended flight is readily proven. Professor Packard observed the moth off the coast of the Eastern States, as also Mr. Burgess. I have observed the moth in October in Buffalo, N. Y., as also Dr. Harvey. According to Mr. Riley the moth has been observed in Chicago, I presume in the Fall. It seems that the moth follows the coast-line northward as also the water courses that empty into the Gulf of Mexico. It is noteworthy here that the water-shed of the Ohio and Mississippi, extends to within fifty miles of Buffalo. As an example of the prolonged flight of moths, I will state, that I have observed in the Gulf Stream, off the Carolinas and out of sight of land, in the month of August, large numbers of a moth, the *Agrotis annexa* of Treitschke.

Again I have been struck by the absence of parasitic checks to the cotton worm in the south. I could never discover any, although such may exist. Spreading as I believe it to do, as a moth, the absence of peculiar parasites to the worm may be reasonably accounted for. I have already and elsewhere pointed out, that in order to make the first brood of the cotton worm the progeny of the so-called "hibernating" individuals (as Professor Riley would suppose), a period of several months has to be accounted for, since these "hibernating" moths could not wait till midsummer to deposit their eggs; and while the cotton is young, and even before it is up, insect life is active, and the weather is warm and other vegetation fully out in the region of the South where I have lived. There is also no reason to believe that the

cotton worm ever breeds in the North, and this, notwithstanding Professor Riley's suggestions to the contrary, in the Sixth Report before mentioned. The worm never has been noticed on any other plant than the cotton, and in the south perishes by thousands rather than eat any other. The habit of wandering in masses when food fails is a proof of this, as while the worm is supplied with cotton leaf it never quits the plant, transforming to the chrysalis on the stalk which has furnished it nutriment. The wandering habit is not normal but accidental, and the worm is not "gregarious" like the "tent caterpillar." Its "hibernation" with us must also be regarded as accidental, or at least as barren of results. For when spring comes the *Aletia argillacea* has vanished, and is not found with the hibernating species of Lepidoptera, renewedly active. And if it *were* found in February and March, it would find no cotton plants upon which to deposit its eggs. If oviposition ever takes place in these months in the cotton belt, the young cotton, free from worms, disproves its efficacy.

It is possible that in the southern portions of Texas, or the Floridian peninsula, the Aletia may sustain itself during the entire year; I have no means of information on this point. My observations are made on its occurrence over the central and principal portions of the cotton belt and into which I believe it to be imported *de novo* every season that it there occurs and from more southern regions.

I conclude, therefore, that while the cotton plant is not indigenous to the Southern States (where it becomes an annual), the cotton worm moth may be considered not a denizen, but a visitant, brought by various causes to breed in a strange region, and that it naturally dies out with us in the cotton belt, unable to suit itself *as yet* to the altered economy of its food plant and to contend with the changes of our seasons.

When this fact is comprehended, it will simplify the process of artificial extermination by limiting the period during which we can successfully attack the cotton worm, and by doing away with a certain class of proposed remedies.

From the foregoing it will be evident that 1. The artificial agent employed to destroy the cotton worm must be employed against the first brood as it appears in any given locality during the progression of the moth northward; and 2. That, in order to be effect-

ual, a concerted action in the application of the remedial agent in any given locality will be found necessary.

I also recommend the introduction of the English sparrow into the Southern States, and additional legal protection to insectivorous birds. Since the war there has been too much ignorant use of the gun on the part of the negroes. *All* the birds should be protected as much as possible, for many species not usually considered insectivorous are yet found, during certain seasons of the year, to live on insects.

I offer the following as the synonymy of the cotton worm in scientific literature:

Aletia argillacea Hübner, Zutr. 3d Hund., S. 32, figs. 399–400 (1822).

Noctua xylina Say,* Sec. Ed. Vol. 1, p. 370 (1859).

Anomis grandipuncta Guenée, Noct., Vol. 2, p. 400 (1852).

Anomis bipunctina Guenée, Noct., Vol. 2, p. 401; id. Vol. 3, p. 397 (1852).

Anomis xylina Grote, Proc. Ent. Soc. Phil., Vol. 3, p. 541 (1864).

Anomis xylina Riley, 2nd Mo. Rep. p. 40, fig. 13 (1870).

Anomis xylina Grote, Rural Carolinian, 3, p. 88 (1871).

Anomis xylina Riley, 6th Mo. Rep. p. 17 (1874).

Aletia argillacea Grote, List of the Noctuidæ of N. America, p. 24.

* In a letter to C. W. Capers, dated Nov. 1st, 1827. I do not know whether this letter is elsewhere published, but this question will not affect the synonymy here proposed

LIFE HISTORIES OF THE PROTOZOA.

BY A. S. PACKARD, JR.

THE design of the present series of papers is to give the results of studies by different authors on the development of the typical forms of animals, beginning with the lowest and ending with man.

I. THE MONERA.

Structure and Habits. Hæckel, in 1868, applied to this group of organisms, which are doubtfully referred to the animal kingdom, the term *Monera* (from μονήρης, simple) in allusion to the extreme simplicity of their structure. "Their whole body," he remarks, "in a fully developed and freely moving condition, consists of an entirely homogeneous and structureless substance, a living particle of albumen, capable of nourishment and reproduction." They differ from the Amœbæ, hitherto supposed to be as simple as any organism, in the want of a nucleus and of contractile vesicles. Moreover, they (as in Protamœba) differ from the Rhizopodous Amœba in being entirely homogeneous in structure, there being, as Hæckel observes, "no apparent difference between a more tenacious outer and a softer inner sarcode mass," as is "perceptible in most, perhaps in all, true Amœbæ."

The motions of these Moners are effected by contraction of the homogeneous substance of the body, and by the irregular protrusion of portions of the body, forming either simple processes (pseudopodia) or a net-work of gelatinous threads. The food is taken in after the manner of the Amœba, the diatom, desmid or some protozoan being surrounded by the pseudopodia and gradually enfolded by the extremely extensible body mass. Hæckel says that reproduction is effected solely in a non-sexual manner. "Often, but not always, the freely moving condition alternates with a state of rest, during which the body surrounds itself with an excreted structureless covering," becoming in fact encysted.

The Monera are divided into two groups:

1. *Gymnomonera*, comprising the genera *Bathybius*, *Protobathybius*, *Protamœba*, *Protogenes* and *Myxodictyum*, which do not become encysted and consequently protected by a case.

2. *Lepomonera*, which become encysted and protected by a case, as in the genera *Protomonas*, *Protomyxa*, *Vampyrella* and *Myxastrum*.

The simplest form of all is Protamœba, which is a simple mass of protoplasm without vacuoles (little cavities), which protrudes simple processes (pseudopodia) not ramifying or forming a net-work. ´ Protogenes differs in protruding ramifying and anastomosing gelatinous threads, while Myxodictyum, the most complicated form, is made up of several simple Actinophrys-like bodies, whose pseudopodia branch out and interlace, forming a net.

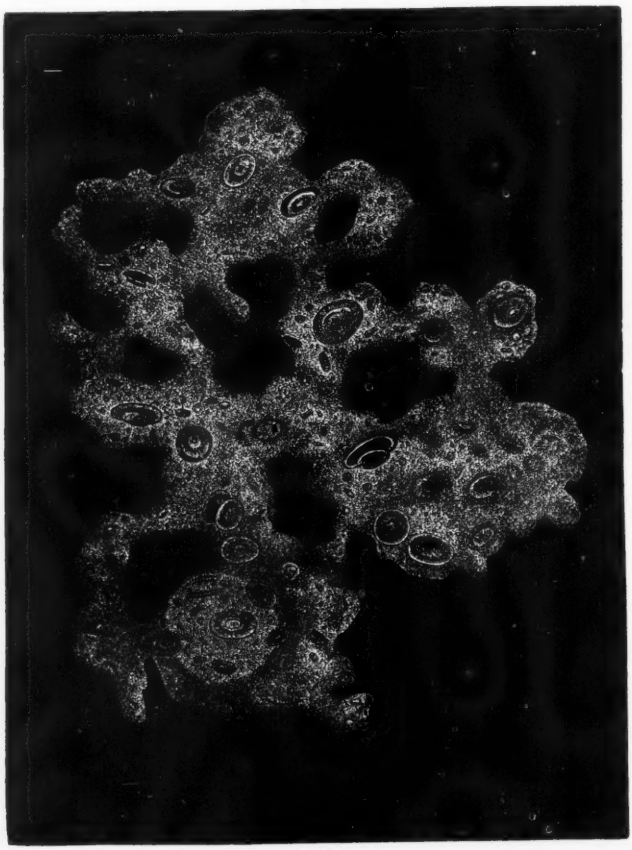
The simplest form of life known to us is Bathybius, a mass of albuminous jelly. If the theory of spontaneous generation should ever prove true we could imagine that the first living form would be like this organism, a mass of jelly, utterly structureless, and yet capable of motion (irritability), of taking food and digesting it, and of reproducing its species, and thus having an individuality.

Bathybius is consequently the most interesting organism (should it be proved to be such.) known except man. It cannot be said to be distinctively either animal or plant, though it has been studied chiefly by zoologists, and intergrades with the higher Moners, which seem to pass by the sum of their characters into the Amœbæ and higher Rhizopods rather than into the Protophytes. But in the Moners we find a group of uncertain forms from which the plant and animal kingdoms diverge, and from which, consequently, they may have taken their origin. The Moners stand in the same relation to the whole world of organized beings that the egg does to the animal kingdom. All animals exist first in the form of nucleated cells, while the primitive form of plants and animals collectively, is a simple non-nucleated mass of protoplasm like Bathybius, and for these forms, neither distinctively plant nor animal, Hæckel's term Protista is a convenient one for *provisional* use.

Bathybius was first discovered by Prof. Wyville Thompson in 1869 in dredging at a depth of 2435 fathoms at the mouth of the Bay of Biscay. He describes it as a "soft, gelatinous, organic matter, enough to give a slight viscosity to the mud of the surface layer." Thompson also adds that if a "little of the mud in which this viscid condition is most marked be placed in a drop of sea water under the microscope, we can usually see, after a time, an irregular net-work of matter resembling white of eggs, distin-

guishable by its maintaining its outline and not mixing with the water. This net-work may gradually alter in form, and entangled granules and foreign bodies change their relative positions." To

Fig. 126.



Bathybius.

this low Moner Huxley has given the name of *Bathybius Hœckelii* (Fig. 126, with coccoliths embedded in the protoplasm, from Thompson's "Depths of the Sea"). This Moner, adds Thompson, "whether it be continuous in one vast sheet, or broken up

into circumscribed individual particles, appears to extend over a large part of the bed of the ocean." It should be stated that Thompson and others do not believe that Bathybius is really an organic being. Bathybius has been discovered at a depth of from fifty fathoms downward in the Adriatic Sea, by Oscar Schmidt. The Bathybius mud was detected by its yellowish-gray color and its characteristic greasy nature.

Under the name of Protobathybius Dr. Bessels mentions a Moner allied to Bathybius, which is a non-nucleated mass of protoplasm. It was discovered at a depth of ninety fathoms, mud, in Polaris Bay, Northern Greenland.

The *Protogenes primordialis* of Hæckel is a simple, shapeless mass of protoplasm, without vacuoles, but with over 1000 very fine pseudopodia, with numerous ramifications and anastomoses. The largest specimens are ·04 inch in diameter. It is a marine form, found at Nice. It reproduces by fission.

Myxodictyum is made up of several individuals, each one of which is like Protogenes, but with fewer pseudopods. *M. sociale* Hæckel, in the single specimen observed, formed a mass nearly an inch and a half in diameter, and was discovered in the Straits of Gibraltar.

Protomonas amyli (Ckski.) is a fresh-water, monad-like form, found by Cienkowski in Germany and Russia, and is from ·08 to ·20 inch in diameter. *Protomyxa aurantiaca* Hæckel has vacuoles in its simple, shapeless, orange-red body, and in the encysted condition is a globular jelly-like mass over half an inch in diameter. It occurred on empty shells of *Spirula Peronii*, floating about on the open sea, and driven in on the coast of one of the Canary Islands. *Vampyrella*, as its name implies, is a jelly-like mass, which according to Cienkowski bores into the cells of confervæ and other fresh-water algæ, and sucks out their contents. Another species, *V. vorax*, engulfs diatoms, desmids and infusoria, drawing them into the interior of its body.

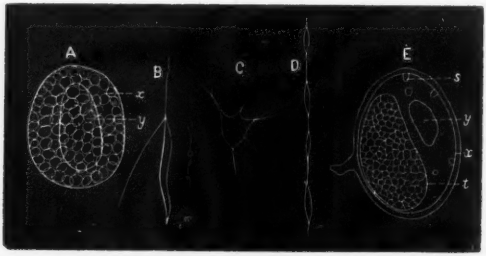
The highest form among the Moners is *Myxastrum radians* of Hæckel, which forms a radiating ball of jelly of tough consistence from ·12 to ·20 inch in diameter. It has very tough, stiff pseudopods. In the encysted condition it is nearly half an inch in diameter, and occurred on the beach of one of the Canary Islands.

Development. In Protamœba and Protogenes, Hæckel tells us we find the simplest possible mode of reproduction. They mul-

tiply by merely dividing into two portions, each part becoming an individual.

The distinguished Russian microscopist Cienkowski has given an account of the mode of development of *Protomonas amyli*, which corresponds to that of the lowest algæ, such as Protococcus (see Clark's Mind in Nature, p. 136, Figs. 73–79); both reproduce by spores; those of the animal Protomonas may be called "zoospores." Fig. 127 (copied from Cienkowski) represents at A this moner during the formation of the zoospores; B, a zoospore hatched out; C, D (A — D × 350 diameters), the Amœba-like form it afterwards assumes. From these stages Cienkowski traced it to the encysted, or resting stage, E; (*y*, food; *s*, a projection inwards of the cell-wall; *x*, moner-cyst × 450). This form lives in putrefying Nitellæ. It should be observed that the

Fig. 127.



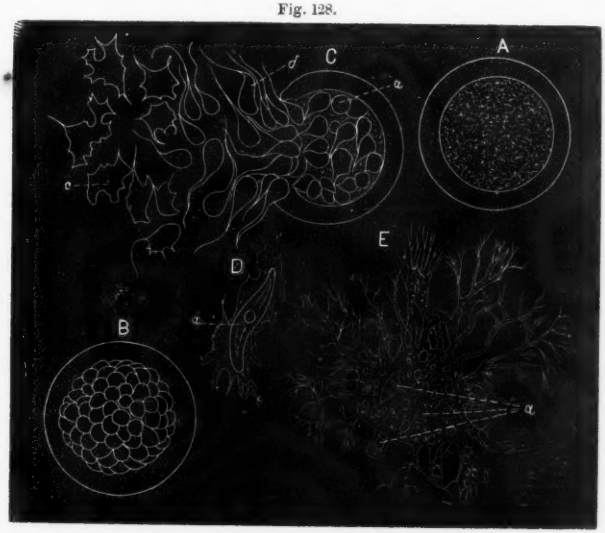
Development of Protomonas.

cyst of this Protomonas, as in the true Monads studied by Cienkowski, is composed of cellulose, while the granular contents become colored with chlorophyll. In these respects they are *plants*, but it should be remembered that cellulose is said to occur in the mantle of the Tunicates and various parts of Articulates and Vertebrates, while chlorophyll occurs in the Infusoria and Hydra.

The course of development of Protomyxa has been observed by Hæckel. The orange-red contents of the ball or cyst (Fig. 128, A) of this moner, divided, after it had retracted itself from the hyaline capsular wall, into several hundred small, round, thoroughly structureless, naked balls (Fig. 128, B). This process Hæckel regards rather as a "germ formation," than a process of division or gemmation. These small globular masses of protoplasm (*a*) are each drawn out into a long tail (*b*), and issue from

the cyst as "swarm-spores" (zoospores, Fig. 128, C *a*, *b*, *c*). These zoospores then assume an amœba-form. These unite by twos or threes, or more, and form a new individual as at D, where two amœba-like germs unite themselves by their anastomosing pseudopods and draw themselves over a Diatom (*a*), meet in the middle, and unite into one individual moner. Fig. 128, E, represents a fully grown *P. aurantiaca* after having had a liberal diet of shelled Infusoria (E, *a*). From the central sarcode body the very strong, branching, tree-like pseudopods radiate, their outer

Fig. 128.



Development of Protomyxa.

anastomoses forming numerous crescent-shaped meshes. The vacuoles extend into the larger pseudopods; they first appear in the Amœba stage after they begin to take food.

This adult, Amœba-like form becomes encysted in the manner thus described by Hæckel. "To complete the natural history of the Protomyxa, it still remained only to observe the encysting of the adult form, the transition from the free moving plasmodia to the stationary red balls which had attached themselves to the Spirula shells near the latter. I succeeded in establishing this also. Two of the largest of the best fed plasmodia, which con-

tained very numerous vacuoli, and which had formed a very extended sarcode net, with many branches and anastomoses, after some time began to slacken their extremely rapid currents, and to simplify their pseudopods. The silicious shells of the many diatoms which had been absorbed were rejected, and the branches and twigs of the pseudopods were successively retracted. At last they drew back the main stems, which had everywhere become simple, into the central plasma-body, and the entirely homogeneous sarcode body took the form of an irregular lump, and finally rounded itself into a regular ball.

"Now commenced the separation of the covering of the cyst, in which the sharply defined single outline of the orange-red plasma-balls passed into a perceptible, though certainly fine, double outline. A second, and then a third, concentric boundary line soon followed this, and then the proper concentric hyaline cyst-covering appeared somewhat quickly (in the course of a day); its layers corresponded with the above stated breaks of the separated gelatinous skin. At first a quantity of vacuoli were still perceptible in the plasma during the encysting process, which appeared and disappeared here and there, but visibly decreased in numbers; and after the complete development of the cyst covering, no vacuoli could be any longer perceived in the orange-red plasma, now interspersed with numerous granules. The encysted plasma-ball was now no longer to be distinguished from those red balls whose transition to the mass of sporules I have above described. Thus was the cycle of the generation of the Protomyxa completed, and the course of its simple and remarkable life history established."

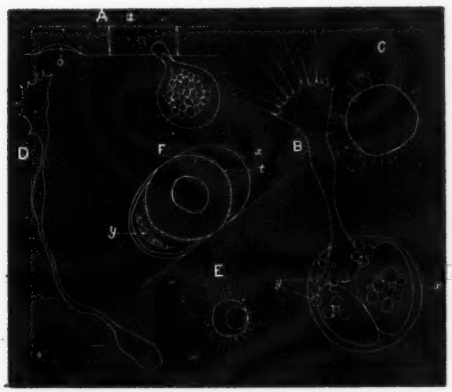
The phases may be thus summed up:—

1. The free swimming flagellate state (sporule or zoospore).
2. The creeping Amœba state.
3. The reticulated Rhizopod state.
4. The encysted state.

Somewhat similar is the development of *Vampyrella spirogyræ*, which penetrates into the cells of the fresh-water plant Spirogyra, and absorbs its protoplasm. Fig. 129, A, represents the adult, with its radiating pseudopods, and a large one in the act of boring into the walls of the plant. It then withdraws its pseudopodia, and assumes what Cienkowski calls the cell-state. During this period it is surrounded by a delicate membrane. The granular

contents divide into three portions, each of which becomes an Amœba-like being (Fig. 129, B, showing one creeping out of the cell, *x*. C, D, E, the Amœba-like stage). Finally one of these

Fig. 129.



Development of Vampyrella.

Amœba-like forms becomes encysted (Fig. 129, F, *y*, the food-granules; *t*, cell-wall of the cyst). To sum up the life-history of Vampyrella as observed by Cienkowski, we have:—

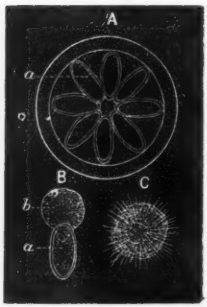
1. An Amœba-stage.
2. A cell-stage.
3. A second Amœba-stage.
4. An encysted stage.

So exactly does this mode of development parallel that of *Colpodella pugnax* described by Cienkowski, who regards it as a flagellate infusorian allied to Monas, that we doubt the naturalness of Hæckel's division of Monera. Colpodella and in fact Protomonas differ from the Monads (Flagellata) simply in having no nucleus. Whether this may not be found on further observation, or whether its absence or presence is so important as Hæckel thinks, future observation will show. We are now inclined to regard the Monera as a somewhat artificial group. It should be noticed that none of the other Moners have a "cell-state," but the Amœba-like organism becomes encysted at once after becoming fully fed.

The development of *Myxastrum radians* of Hæckel is much like

that of Protomyxa, but differs in some important respects. The cyst becomes filled with numerous conical portions, whose points rest towards the centre of the ball, while their rounded bases produce a mulberry-shaped outline externally. In the next stage these cone-shaped divisions have assumed a spindle shape, and each separate spore has developed a silicious covering (Fig. 130, A, *a*). When the spindle-shaped spore has been set free the protoplasmic contents (*b*) slip out of the silicious shell (Fig. 130, B, *a*), and assume an Amœba form, with numerous radial pseudopods (Fig. 130, C), which in the fully formed Moner become as long as the diameter of the body.

Fig. 130.



Development of Myxastrum.

With the facts that have been presented, the question arises whether these moners are animals or vegetables. Structurally, and in their mode of development, the Monera would seem not to differ essentially from the lowest plants, such as the Myxomycetes and lowest Algæ; but physiologically, or *in what they do*, they differ, as H. J. Clark (Mind in Nature, p. 151, 156) says of Amœba, in taking in living organisms entire, digesting their protoplasm and rejecting the silicious coverings of the diatoms or infusoria they have swallowed. The plants of correspondingly low organization on the contrary absorb only the elements in an unorganized state.

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II. THE GREGARINIDA.

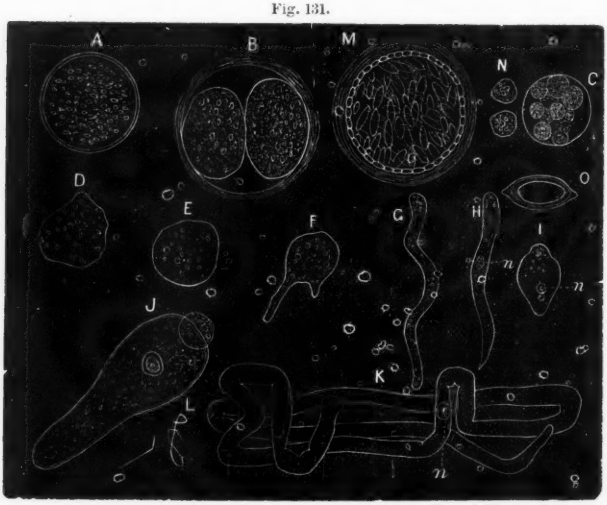
Structure and Habits. First discovered by Dufour, these parasitic protozoans, with an organ, *i. e.*, a nucleus, were considered as the lowest animals until the discovery by Hæckel of the still simpler Monera. It is now known that they pass through the Moner-state and attain a true Amœba condition, having an outer, clear,

muscular, and an inner, medullary or granular, layer, which are more distinct than in the Amœbæ, and also a nucleus. In form they are more or less worm-like. They are parasitic, living in many types of animals, especially the insects and worms, and vary greatly in form. The largest species known is *Gregarina gigantea* (Fig. 131 after Van Beneden), which lives in the intestinal canal of the European lobster. It is worm-like, remarkably slender, being ·64 inch in length. It is, in fact, the largest one-celled animal known, and in size may be compared with the cells of some vegetables; in the animal kingdom it is only surpassed by the eggs of birds, which are really cells. In this organism an external, structureless, perfectly transparent membrane, with a double contour, can be very clearly distinguished. It represents the cell wall of other cells. Beneath this outer wall is a continuous layer of contractile substance, by which these animals retain their form, not changing as in the Amœba. It was first discovered in 1852, by Prof. J. Leidy. He showed that there existed under the cuticular, structureless membrane, a so-called muscular layer, which in contracting becomes longitudinally folded, so as to produce a marked striation. Van Beneden adds that in "the immense Gregarina of the lobster I have assured myself of the presence of, under the cuticle, a true system of muscular fibrillæ, comparable to those of the Infusoria." From this fact he places these animals above the Amœbæ, which move by the simple contractility of their sarcode or protoplasm, a property of all animal and vegetable protoplasm generally. He therefore opposes the opinion of Hæckel that the Gregarina is an Amœba, degraded by its parasitic life.

The internal granular matter of the Gregarina is extremely mobile, like protoplasm generally. "The whole cavity of the body is filled," says Van Beneden, "with a granular matter formed by a viscid liquid, which is perfectly transparent. This holds in suspension fine granulations of a rounded form, which are formed by a highly refractive and slightly yellow matter." In this granular matter the nucleus is suspended. The nucleus is surrounded by a membrane, and the cavity of the vesicle is filled by a homogeneous, colorless and transparent liquid. This nucleus contains an inner vesicle, or nucleolus, which has the singular feature of spontaneously appearing and disappearing in a very short space of time. "If one of these Gregarinæ of moderate size is observed, the nucleus is seen at first provided with a single nucle-

olus, presenting some seconds later a great number of little refracting corpuscles, of very variable dimensions, which are also nucleoli. Some of these enlarge considerably, whilst the primitive nucleolus diminishes in volume little by little, finally disappearing. The number of nucleoli varies at every instant." These novel observations are considered of great importance by Van Beneden as showing that the nucleolus of the Gregarina, and consequently the nucleoli of cells generally are sometimes, if not always, devoid of a membrane. And he draws the inference "that the nucleus of a cell is not necessarily a vesicle, and that

Fig. 131.



Development of Gregarina.

contrary to the generally received opinion, a nucleus of a cell may be equally devoid of membrane," though we may add that he saw it in the Gregarina of the lobster. Van Beneden distinguishes three kinds of motions in the Gregarinæ. 1. They present a very slow movement of translation, in a straight line and without the possibility of distinguishing any contraction of the walls of the body which could be considered as the cause of the movement. It seems impossible to account for this kind of motion. 2. The next kind of movement consists in the lateral displacement of every part, taking place suddenly and often very violently, from a

more or less considerable part of its body. Then the posterior part of the body may be often seen to throw itself out laterally by a brusque and instantaneous movement, forming an angle with the anterior part. 3. Owing to the contractions of the body the granules within the body move about.

Development. The history of Gregarina has been worked out by Siebold, Stein, Lieberkuhn, and more recently by E. Van Beneden. The course of development is as follows: the worm-like adult, *G. gigantea* (Fig. 131, K, *n* nucleus, L, two individuals natural size), which is common in lobsters on the European coast in May, June and August, becomes encysted in September in the walls of the rectum of the lobster, the cysts (Fig. 131, A) appearing like "little white grains of the size of the head of a small pin." When thus encysted the animal loses its nucleus, and the granular contents of the cyst divide into two masses (B), like the beginning of the segmentation of the yolk of the higher animals. The next step is not figured by Van Beneden, and we therefore introduce some figures from Lieberkuhn which show how the granular mass breaks up into zoospores (called by authors "pseudonavicellæ," and by Lieberkuhn "psorosperms") with hard shells. After the disappearance of the nucleus and vesicle, and when the encysted portion has become a homogeneous granular mass, this mass divides into a number of rounded balls (Fig. 131, C). These balls consist of fine granules, which are the zoospores in their first stage (Fig. 131, N). They then become spindle-shaped (O), and fill the cyst (Fig. 131, M), the balls having meanwhile disappeared. From these zoospores are expelled Amœba-like masses of albumen (D, E) which, as Van Beneden remarks, exactly resemble the Protamœba already described. This moner-like being, without a nucleus, is the young Gregarina.

But soon the Amœba characters arise. The moner-like young (Fig. 131, D, E) now undergoes a further change. Its outer portion becomes a thick layer of a brilliant, perfectly homogeneous protoplasm, entirely free from granules, which surrounds the central granular contents of the cytode (Hæckel) or non-nucleated cell. This is the Amœba stage of the young Gregarina, the body, as in the Amœba, consisting of a clear cortical and granular medullary or central portion.

The next step is the appearance of two arm-like projections (Fig. 131, F), comparable to the pseudopods of an Amœba. One

of these arms elongates, and separating forms a perfect Gregarina. Soon afterwards the other arm elongates, absorbs the moner-like mass and also becomes a perfect Gregarina. This elongated stage is called a Pseudofilaria (Fig. 131, G). No nucleus has yet appeared. In the next stage (Fig. 131, H, *n*, nucleus) the body is shorter and broader, and the nucleus appears, while a number of granules collect at one end, indicating a head. After this the body shortens a little more (I, J), and then attains the elongated, worm-like form of the adult Gregarina (K). Van Beneden thus sums up the phases of growth :—

1. The Moner phase.
2. The generating Cytode phase.
3. The Pseudo-filaria phase.
4. The Protoplast* (adult Gregarina).
5. The encysted Gregarina.
6. The sporogony phase (producing zoospores).

It seems evident that the mode of development of the Gregarina in part corresponds quite closely with the mode of growth of the Moners; for example, it becomes encysted, *i. e.*, sexually mature, produces zoospores (pseudonavicellæ), and from these zoospores issues the young or larval form of the Gregarina. These zoospores abound in damp places and are devoured by insects and worms. After they are swallowed the shells burst and the Amœba-like young are set free in the body of their host.

It will be seen that there is here a total absence of sexual reproduction. The Moner-stage arises by self-division of the contents of the cyst, a process analogous to the segmentation of the yolk of eggs; and the Pseudofilariæ arise by self-division of the young in the Moner-stage, *i. e.*, by a budding process.

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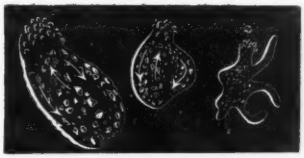
*The Gregarinæ and Amœbæ constitute Hæckel's group of *Protoplasta.*

III. THE RHIZOPODA.

Structure and Habits. We have almost anticipated a definition of the Rhizopoda, of which the Amœba, or Protean animalcule, is the simplest form, by our frequent references to the "Amœba-form" or "Amœba-like" stages in the Moners and Gregarinas. The Amœba is the starting point, the unit of the nucleated Protozoa, the primitive, ancestral form to which the members of the subkingdom may be reduced. Until the Monera were discovered the Amœba was regarded as the lowest possible animal.

With the form of the Monera, a shapeless mass of protoplasm, changing each instant, throwing out threads or larger protrusions of the body, the Amœba possesses a distinct organ, the nucleus, and its body mass is divided into a clear cortical and a medullary granular mass; the outer highly contractile, the inner granular portion acting virtually as a stock of food. These granules, like the grains of chlorophyll in vegetable cells and Diatoms and Desmids, circulate in regular fixed currents, according to J. H. Clark. (See Fig. 132, after Clark; the usual form of *Amœba diffluens* Ehrenberg, magnified 100 diameters; the arrows indicate the course of the circulating food. The head end is knobbed, and within free from granules.) We have then in Amœba:—

Fig. 132.



Amœba.

1. A nucleus, probably representing the nucleus and ovary of the Infusoria.
2. A head and posterior end.
3. A circulation analogous to that of the Infusoria.

This animal, as we may justly call it, since it takes in living protozoans and rejects their shells, has the power of moving in a particular direction, one end of the body always advancing first; which indicates the rudiments of a nervous and muscular power; and can swallow, digest and circulate its food. Whether it gives out nitrogen and absorbs oxygen or not is unknown. It reproduces by self-division, and some allied forms by the production of monad-like, flagellate spores.

The Amœba is a fresh-water form, living on the stems and

leaves of fresh-water plants. The late H. J. Clark, our most eminent microscopist, thus describes its habits in his "Mind in Nature." "The three figures represent the various forms which I have seen the same individual assume, whilst I had it under the microscope, as it crept over the water-plants upon which it is accustomed to dwell. The most usual form which it assumed is that of an elongated oval (A), but from time to time the sides of its body would project either in the form of simple bulgings (B), or suddenly it would spread out from several parts of the body (C), as if it were falling apart; just as you must have seen a drop of water do on a dusty floor, or a drop of oil on the surface of water; and then again it retracted these transparent arms and became perfectly smooth and rounded, resembling a drop of slimy, mucous matter, such as is oftentimes seen about the stems of aquatic plants."

Pelomyxa (Fig. 134) is a fresh-water Amœba-like form, but provided with spicules. Under the name of *Amœba sabulosa* Prof. Leidy describes* a form which he thinks "is probably a member of the genus Pelomyxa," and which is characterized by the comparatively enormous quantity of quartzose sand which it swallows with its food. "The animal might be viewed as a bag of sand!" It is from one-eighth to three-eighths of a line in diameter, and was found on the muddy bottom of ponds in Pennsylvania and New Jersey. It is possibly *Pamphagus mutabilis*, figured by Professor Bailey in the "American Journal of Science and Arts," 1853. Another form resembling Greef's Pelomyxa, and found by Professor Leidy in a pond in New Jersey, is *Deinamœba mirabilis*;† its body bristles with minute spicules. He has also described in the same Proceedings (p. 88) *Gromia terricola*, which lives in the earth about the roots of mosses growing in the crevices of the bricks of the pavements of the streets of Philadelphia. He thus graphically describes this singular form. "Imagine an animal, like one of our autumnal spiders, stationed at the centre of its well spread net; imagine every thread of this net to be a living extension of the animal, elongating, branching, and becoming confluent so as to form a most intricate net; and imagine every thread to exhibit actively moving currents of a viscid liquid both outward and inward, carrying along particles of food and

*Proceedings of the Academy of Natural Sciences, Philadelphia, 1874. p. 86.
†l. c. p. 142.

dirt, and you have some idea of the general character of a Gromia."

A convenient division of the Rhizopods is into two groups, Foraminifera and Radiolaria. Schultze divides the former into :—

1. *Nuda*, or naked forms, such as Amœba and Actinophrys.

2. *Monothalamia*, forming a one-chambered shell, but with the animal undivided, living in the simple hollow of the shell. Fresh-water forms are Arcella, Difflugia and Gromia, while Cornuspira is a marine form.

3. *Polythalamia*, with many-chambered shells ; all marine. The three divisions are represented by (1) Acervulina, (2) Nodosaria and (3) Miliola, Rotalina, Globigerina, Textularia, Nummulina, Polystomella, etc.

The Rhizopods are divided by Hæckel into 1. *Acyttaria*, or the one and many chambered Foraminifera; 2 The *Heliozoa*, represented by *Actinosphærium* (*Actinophrys*) *Eichhornii*, or sun-animalcule ; and 3. The *Radiolaria*. These last two groups he divides (*a*) into the *Monocyttaria* (represented by Cyrtidosphæra, Thalassicolla and Acanthometra, etc.) and (*b*) the *Polycyttaria*, represented by Collozoum, Sphærozoum and Collosphæra. Hæckel, who has studied these Radiolaria more than any one else, though Johannes Müller gave us the first definite information about them, says that "in the lower forms they are allied to the sun-animalcules and Foraminifera, but the higher forms are much more highly developed. They differ from both the Actinophrys and Foraminifera, in that the central part of the body is made up of many cells, and is surrounded by a strong membrane. This closed, more or less spherical "central capsule" is surrounded by a slimy layer of protoplasm, from which thousands of very fine threads radiate, and often branch out and anastomose. Among them are scattered numerous yellow cells, which contain starch granules." (Whether these yellow cells are parasitic organisms, or belong to the animal, is not yet known.) Most Radiolaria are provided with a highly developed silicious frame-work, like the outer shell of a nest of Chinese carved balls, the outer surface of which is studded with spines ; but both the form of the silicious box and the spines varies greatly, as may be seen by a glance at the plate in volume III* (after J. Müller), illustrating the Polycystina. Some Radio-

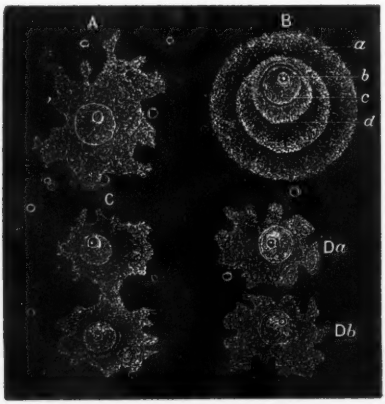
* Explanation of the plate. Fig. 1, *Tetrapyle octacantha* ; Fig. 2. *Haliomma amphidiscus* ; Fig. 3, *Haliomma longi-spinum* ; Fig. 4, *Haliomma hexacanthum* ; Fig. 5, *Haliomma?*

laria have a many chambered shell like those of the Polythalamia.

While the Foraminifera live mostly at the bottom of the sea (some, however, occurring between tide marks) on stones and seaweeds, creeping over sand and mud by means of their pseudopods, the marine Radiolaria for the most part float with outstretched pseudopods on the surface of the sea. They occur in countless numbers, but are usually so small that until 1858 they had been almost entirely overlooked by naturalists. The compound, or social forms, such as Collosphæra, are nearly an inch in diameter, while most of the simple species cannot be seen with the naked eye. The Polycystina occur fossil in abundance at Barbadoes, Richmond, Va., and the Nicobar islands.

Development. So far as is known Amœba multiplies its kind only by the simplest mode of reproduction known, that of self-division. The following figure (133), copied from Hæckel, represents

Fig. 133.



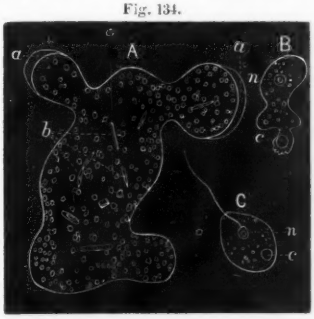
Amœba sphærococcus.

highly magnified, *Amœba sphærococcus*, a fresh-water species without a contractile vesicle, in the process of fission; at B is the encysted Amœba in its "resting stage." It now consists of a spherical lump of protoplasm (*d*), in which is a nucleus (*c*) with its nucleolus (*b*) and the whole surrounded by a cyst or cell-membrane (*a*). It breaks the cell-wall and becomes free as at

A. Self-division then begins as at C, the nucleus doubling itself, until at *Da* and *Db*, we have as a result two individuals.

In Pelomyxa, a higher form than Amœba, we have according to Greef a production of ciliated zoospores. This form, described by Greef under the name of *Pelomyxa palustris* (Fig. 134, A, *a*, clear portion; *b* diatoms enclosed in the body mass), lives in the mud at the bottom of pools, and when first seen resembles little dark balls of mud ·04–·05 inch in diameter. The body mass contains numerous vacuoles filled with water, and numbers of nuclei and spicules. These nuclei, and spicules have a dancing motion, like the ordinary Brownian movements of molecules. There are also numerous hyaline, oval or rounded bodies which Greef calls "shining bodies," and which originate from the nuclei. They increase by division within the body-mass of the Pelomyxa, becoming Amœba-like bodies (Fig. 134, B, *n* nucleus, *c* contractile vesicle) which issue in great numbers from the parent-mass. These Amœboid forms gradually pass into flagellate zoospores (Fig. 134, C) with a nucleus and contractile vesicle. It thus seems that the zoospores of this Rhizopod are produced without the animal becoming encysted.

Fig. 134.



Pelomyxa palustris.

As regards the development of Actinophrys and the allied spiny forms, Greef thinks that besides being formed by direct self-division, there is a resting or encysted stage. "The latter consists in the withdrawal of the sarcode body-mass from the inner boundary formed by the union of the bases of the radial spines, leaving a rather wide empty border, and its becoming invested by a double coat, viz., a firm inner one, when empty, dotted, as if perforated, and an outer hyaline one."

According to Schneider, *Actinophrys Eichhornii* undergoes division; the central mass divides twice or thrice. Then the alveolar cortical layer disappears, and each mass resulting from the self-division becomes encysted. This process is undergone in two days. It remains encysted through the winter until the beginning

of May, when the cyst drops off and a small Actinophrys with a number of nuclei appears.

As an example of the reproduction of these forms by fission, we may cite the case of *Gromia socialis*, figured by Archer. He represents the body of a Gromia after having undergone a transverse self-fission, having in each portion a nucleus with its nucleolus, the upper segment giving off branched pseudopodia as usual.

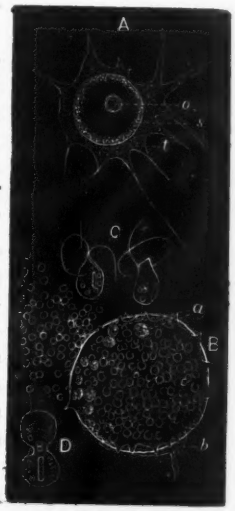
Of the mode of development of the shelled Amœbæ or Foraminifera (Polythalamia), numerous and often accessible as these animals are, we know but little. In fact, we have only the fragmentary observations of Max Schultze, made in 1856, on a species of Miliola sent him from Trieste. He says that this Foraminifer, after remaining from eight to fourteen days in the same place on the side of the jar, became surrounded with a thin layer of brownish mud, so that the shell was lost to view. On the 15th of May he noticed that small, round, sharply defined bodies escaped from the brownish slimy mass, and after some hours as many as forty such bodies surrounded the Miliola. These round bodies were young Foraminifera in calcareous shells with one turn, but no inner walls, somewhat resembling Cornuspira, and with pseudopodia already like those of the adult. It is probable, therefore, that the shell of the young is formed within the parent. Schultze adds that the almost complete want of organic contents in the shell of the parent at this time, rendered it probable that the whole or greater part of its body had passed into those of the young.

Of the mode of development of the Radiolaria, Prof. Cienkowski afforded, in 1871, the first definite information. He states that "J. Müller saw in the interior of an Acanthometra a swarming of small monad-like vesicles, which moved about for a time, and then changed themselves into Actinophrys-like structures. Afterwards," Hæckel saw, first, in Sphærozoids, "the contents of the capsules break up into many vesicles, and secondly, in Sphærozoum, he observed masses of vesicles which exhibited a vibratory movement." Lastly, Schneider had noticed in Thalassicolla groups of amœboid vesicles with movable flagellum-like processes. These facts rendered it probable, what Cienkowski has proved, that the Radiolaria reproduce by motile germs, *i.e.*, zoospores.

He studied the compound forms, such as Collosphæra and Collozoum, which are composed of aggregations of capsules (Fig. 135 A,

a capsule of a young Collosphæra without the latticed shell), held together by a common mass of protoplasm. These capsules are separated by a certain interval from one another, while the protoplasm binding them together consists of alveoli (vesicles) of various sizes, between and on to which sarcodic threads and networks are disposed. "I always found," he adds, "the capsules supported on the surface of the alveoli, often lenticular, compressed, and enclosed by a radiating layer of protoplasm, which also spreads itself over the alveoli, and passed over continuously into the sarcodic envelope of neighboring capsules. Besides those alveoli which carry capsules, there are many smaller, which are free from capsules."

Fig. 135.



Collosphæra.

Collosphæra spinosa (Fig. 135, B) possesses a fenestrated shell beset with small spines, which encloses a capsule with a protoplasmic investment. Fig. 135. B, *a*, indicates the problematical yellow cells. Fig. 135, A, indicates a young capsule of another spineless species, *C. Huxleyi* Müll. The young capsule of this species is naked, embedded, without any shell, in a radiated protoplasmic sheath, not emarginated by any sharply marked envelope. "In this stage they often divide themselves by fission into two halves. Not until maturer age does the capsule obtain a resisting membrane, and become enclosed in a fenestrated shell.

The next change which takes place in the capsule is its division into a number of little spheroids. This process is accomplished in a single day in *C. Huxleyi*. These spheroids become monad-like bodies, filling the capsule with a mass of corpuscles having a tremulous movement, and which finally swarm out in all directions (Fig. 135, B) from the capsule as true zoospores (C). The capsules now die and break up. These zoospores are provided with two long cilia. In the interior are a few oil drops, and a little crystalline rod, which sometimes projects out of the body.

"Among the swarms of swimming zoospores lay many motion-

less ones dispersed," continues Cienkowski. "They were round or angular, with drawn-out points," and one or more constrictions could be seen in them (Fig. 135, D). "Apparently they were developmental stages of the zoospores, obtained as they were in course of formation from the contents of the capsule." Cienkowski observed the same process in *Collozoum inerme*, thus substantiating his observations on Collosphæra.

In the Rhizopods, then, we know certainly two modes of reproduction:—

A. By self-division, as in Amœba.

B. By the production of zoospores, as in the Radiolaria.

In the latter the following phenomena take place:—

1. The capsule is filled with spheroids by a probable division of the contents of the capsule, as in the encysted stage of Moners and Gregarinida.

2. The "out-swarming" of zoospores.

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B. Foraminifera.

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REVIEWS AND BOOK NOTICES.

INTRODUCTION TO GENERAL BIOLOGY.*—Though the plan of this little manual is good, being identical with the arrangement of the examination questions in the Science and Art Department of Instruction at South Kensington, we cannot speak favorably of its execution, or advise the use of the book in this country, unless carefully revised. A want of special knowledge of the subject, and the usually execrable woodcuts, wherever not copied from other works, detract seriously from the value of the book.

PUBLICATIONS OF WHEELER'S SURVEY.†—Besides the maps issued by this survey we now have a Catalogue of Plants collected in the years 1871, 1872 and 1873, with descriptions of a few new species, by Mr. Sereno Watson and Dr. J. T. Rothrock, botanist, aided by Messrs. Hoopes, Olney, Vasey, Eaton, James and Austin.

The report upon the birds collected in Utah and Nevada during the same years, by Dr. Yarrow, abounds in notes on habits and geographical distribution.

THE GEOLOGICAL SURVEY OF INDIANA.‡—While this last year's report of the Survey is mainly on economic geology, as it should be, it contains some archæological and palæontological notes of interest.

BOTANY.

YUCCA FILAMENTOSA.—Dr. Engelmann's interesting observations on the genus Yucca, and Prof. C. V. Riley's discoveries in relation to the yucca moth,§ have turned attention generally to this family of plants. The *Yucca filamentosa* is the species most commonly cultivated in the central United States. It is found

* An Introduction to the Study of General Biology, designed for the use of School and Science Classes. By Thomas C. MacGinley. With 124 illustrations. Putnam's Elementary Science Series. New York, G. P. Putnam's Sons. 12mo. pp. 199. Price 75 cts.

† Report upon Ornithological Specimens collected in the years 1871, 1872 and 1873. By Dr. H. C. Yarrow. Washington, D. C. 8vo. 1874. pp. 148. Catalogue of Plants collected in the years 1871, 1872 and 1873, with descriptions of New Species. Wheeler's Geographical and Geological Explorations and Surveys West of the 100th Meridian. Washington, D. C. 1874. 8vo. pp. 62.

‡ Fifth Annual Report of the Geological Survey of Indiana, made during the year 1873. By G. T. Cox, State Geologist, assisted by Prof. John Collett, Prof. W. W. Borden and Dr. G. M. Levette. Indianapolis, 1874. 8vo. pp. 494. With plates and maps.

§ Trans. St. Louis Acad. Science, 1873, and AMERICAN NATURALIST, vol. 7.

growing wild in Virginia and southward. The generic name *Yucca* is supposed to be of Indian origin; its signification is not known. The specific name *filamentosa* is expressive of the thread-like filaments found on the edges of the leaves. The popular names of this plant are Spanish bayonet, Adam's needle and bear grass. The name first mentioned was probably suggested by the form of the leaves. In the backwoods of West Tennessee this yucca is called "bar grass," "bar" probably being the rural for bear; the tough leaves are used there for suspending meat in the smoke-house. The peculiar perfume of the flowers of this plant is not perceptible in the daytime. I have known floriculturists who have had the plants in their gardens for years without discovering that they possessed fragrance. In this latitude, Jacksonville, Ill., the perfume begins to exhale about 7 o'clock, P. M. It is sufficiently like that given off from a wasp when disturbed, to make nervous persons uneasy if unacquainted with its origin. It is worthy of note that the Yucca moth makes its appearance on the plant soon after its perfume becomes perceptible. This summer, having a blooming plant of the *Y. filamentosa* in my garden, I determined to see what I could of its wonders for myself; my tools were a simple hand microscope and a number of little tarlatan bags with draw strings. With the latter, four experiments were tried. The first one was to test the ability of the flower to pollenize itself. Four large buds on different branches and almost ready to open, were selected, a bag was drawn over each of these and fastened by the draw string to the stem beyond the flower. With the view of throwing as much strength as possible into the flowers operated on, all the other flowers on these branches were removed. The buds expanded in their gauzy covering as perfectly as their unveiled sisters, but like nuns of another order they drooped and died, leaving no progeny behind them. The second experiment was to pollenize the flower, by itself, artificially. The buds were gently opened and some pollen scraped from their anthers with a small penknife and placed in the entrance to the stigmatic tube. The buds were then enveloped in bags and the branches stripped off the other flowers and buds as in the former case. These also failed to develop seeds. The third experiment was to pollenize artificially from another plant. The operation was conducted like the above, and like the above failed to produce seeds. The fourth experiment was to pollenize

artificially from other flowers on the same plant. One large perfect capsule of seed resulted from this attempt. In this capsule the indentations around the middle, which forms so constant a feature in this species was not present. Was this variation from the usual form the result of unusually perfect fertilization, or from the protection from the puncture of insect afforded the seed-pod by the gauze? This peculiarity of the seed-pods of the filamentosa calls for further investigation. If it be a development of the natural growth of the plant and not caused by external agencies, it is interesting to note how it may be made to vary as in the above case. If it be caused by deficient fertilization or from the puncture of insects, why are the indentations so uniformly in the middle of the capsule?

In the three experiments where pollen was used, the pollen was placed as nearly as possible in the same position in each flower, viz., just at the entrance to the stigmatic tube; the result confirms the view taken by Dr. Engelmann in relation to the difficulty of this flower being pollenized by other natural agencies than that afforded by the yucca moth. She thrusts her mass of pollen far into the stigmatic opening, thus insuring fertilization. If, as is probable, the yucca plant preceded the yucca moth in existence, the plant is so prolific in bloom and in seeds, that if but a very small proportion of the flowers were fertilized by the usual agencies, there would still be enough seeds produced to perpetuate the species abundantly; for each capsule contains from one to three hundred seeds. After the seeds on my plant had turned black and before the yucca grubs had eaten out, forty-one capsules were carefully examined, of these twenty-four contained grubs, one held six of the little fellows. In no case was there more than one grub found in the same end of a row of seeds, occasionally one was found at each end of a row and the grubs were found quite as often at one end as at the other of the capsules. My plant was frequently disturbed. It would appear from the unusually large proportion of capsules without grubs, that the moth may be more successful in fertilizing the flowers when disturbed, than in finding a safe harbor for her eggs. If the discoveries made in regard to the fertilization of this plant can be sustained on further investigation, more than ordinary intelligence must be ascribed to the yucca moth, 1st, for her foresight in making ready the way for her progeny to be supported, and this, by *indirect* means; 2nd, in

her wise disposition of her eggs so that the larvæ cannot interfere with each other's supply of food. May not this little insect while fluttering around within the flower, seeking a place to deposit her eggs, accidentally become laden with pollen? Then, when her work is done and she ascends the stigma to regale herself with its sweets, she brings her pollen-laden antennæ in contact with the stigmatic surface, thus unwittingly performing her part in this life drama.—J. M. MILLIGAN.

THE DISTINCTIVE FEATURES OF APPLE FLOWERS. — We make a brief abstract of an essay on this subject by Prof. W. J. Beal, of the Michigan Agricultural College. The essay is contained in vol. iii of the Report of the State Pomological Society. Each flower bud of the apple contains five to eight flowers. The centre flower opens first, and is often provided with poor anthers; it is most likely to set for fruit so far as the author has observed. The immense number and often very great similarity of varieties of apples make it often difficult to recognize and define them by the fruit alone, as is mostly done. No pomologists that he could hear of have made any use of the flowers of apples as a means of classifying them. He says, "the petal of the red astrachan is one and a fourth inches long by three-fourths broad. It is ovate. The petal of a Tolman Sweet is twelve-sixteenths by seven-sixteenths of an inch, and is elliptical. Its length is about the breadth of the red astrachan. The petal of the Porter is thirteen-sixteenths by twelve-sixteenths and is nearly orbicular. It is also cordate at the base, different from the other two varieties. Large numbers of flowers were examined on several trees of each, except the Porter. The petal of the sweet bough is seventeen-sixteenths by fourteen-sixteenths of an inch. It is broadly ovate, with a stem or claw longer than either of the other three varieties mentioned. Other varieties were examined with similar results. The styles also vary much in size and in other respects in different varieties. They are usually united about half-way, and mostly smooth for the greater part of their length. In the Tolman Sweet, the styles are united in one small column for half their length, then appear larger. The upper half of the styles are closely covered and bound together by a dense woolly substance, unlike the styles of any other variety examined. The sepals also differ considerably in different varieties." The author is confident that much use

can be made of the flowers in defining varieties of apples. This may seem a simple matter to botanists, but it must be new to most pomologists, for some of the best of them say there is little difference in the flowers of apples.

ZOOLOGY.

NOTE ON THE SYNONYMY OF TELEA POLYPHEMUS.*—In a paper read before the Royal Dublin Society, March 18, 1872, Mr. W. F. Kirby prefers the name *paphia* L., for our common species of Telea, and says: "It has, I think, been questioned whether Cramer's *Attacus polyphemus*, from Jamaica, is identical with this common species." It is Dr. Packard who writes of Cramer's figures under the names "Cecropia," "Polyphemus" and "Promethea," as received from the West Indies, that they "would lead one to suppose that they represented distinct species," from those we know from the United States under these names (Proc. Ent. Soc. Phil., 1864, p. 381).

Having received *Telea Polyphemus* from Matamoras, collected by my brother, Capt. F. Harris Grote, and it having been recorded from California by Mr. H. Edwards, we can assign a wide range to this species. Farther to the southward it may be replaced by the Mexican *Telea Montezuma* Grote, Trans. Am. Ent. Soc., 2, p. 118. My studies of this Bombycid lead me to believe that the typical Attaci are entirely unrepresented in the West India Islands. The positive demonstration of this as a fact would be highly interesting as throwing some light on the geological history of the Islands. I am, then, inclined to regard Cramer's habitat for our Attaci as erroneous, and to account for the discrepancies of his figures, by an infidelity of execution.

I do not find any description of a species of Attacus under the name Polyphemus by Linné. The first description seems to be that of Cramer, and the species is afterwards described under the same name by Fabricius (Species Insectorum). This corrects the synonymy proposed by Dr. Packard, who cites Linné as authority for the species, referring to the "Syst. Nat. (1767)."

Linné describes his *B. paphia* first in "Syst. N. X." 1758, as from "Guinea," p. 496, No. 4, and cites "Petiv. Gazoph." tab.

* I am indebted to Dr. Hermann A. Hagen of Cambridge, Mass., for bibliognostic information used in the present article.

29, f. 3, which I cannot consult and, *doubtfully*, "Catesby" Car. 2, p. 91, tab. 91. The species intended by Linné cannot, I think, be our Polyphemus.

In Mus. Lud. Ulr. 1764, p. 369, No. 4, Linné describes in extenso *B. paphia* from septentrional America, and cites Catesby, this time without doubt, as also Petiver and Rumphius. The description hardly applies to our species, but this is the only one that admits of the probability. Finally in the twelfth edition of the "Systema Naturæ," 1767, p. 809, No. 4, Linné cites Catesby *again* with *doubt*, and gives Guinea, Asia, as the habitat of his *B. paphia*.

Of his *B. paphia* (Mus. Lud. Ulr.) Linné says: "Ocellus primoris similes in medio; postice pallidiores versus marginem et obsolete undulate," and "Ocelli utriusque alæ in mare oblonga, in femina orbiculati, quorum qui in aliis posticis cincti nigr. violacea," which in part does not agree with our species.

I think, then, that the *B. paphia* of Linné's tenth and twelfth editions of his "Systema Naturæ" is not our Polyphemus, while that of his Mus. Lud. Ulr. may be. This latter will not affect the specific name of our common species, which appears to be confined to continental North America and not to occur in the West Indies.—Aug. R. Grote.

The Reversion of Thoroughbred Animals.*—The improvement in live stock has been greater than in tillage. It has been accomplished by (1) selection of breeding animals, and (2) by care of them. Both of these are essential. Starved animals will not thrive, no matter how well bred, and no skill in care and feeding will give from poor breeds the best of animals. Special excellences are the accumulated improvements of several generations.

It is often claimed that if the care of man be withdrawn the improved breed will retrace the steps of its ancestry and revert to its original characteristics. This theory has been made a dogma and the basis of deductions regarding the permanence of original types and the fleeting nature of acquired characters. The dogma finds a place in scientific literature in papers read before learned societies, and from these sources the notion spreads through our popular literature. It has weight with a class of farmers who do

* Read at the Hartford Meeting of the Amer. Assoc. Adv. Science.

not wish to expend money and care on their live stock — to have the best, and care for it in the best manner. They suppose that the moment their care is withdrawn, the objects of it will begin to "revert" to original inferiority. This wide-spread belief greatly impedes the general improvement of live stock.

Instances of this alleged "reversion" were brought forward at the last annual meeting of this Association, and are printed among the papers then delivered. About a month later there was a meeting held in a neighboring state. Stock breeders came from England, from California, from even the very state where they had just been told that "shorthorns" were prone to return to their original state. The meeting was for the sale of improved animals, and in 30 minutes the sale of shorthorns amounted to $250,000, and there also, within a very short time, 109 head of cattle were sold for $382,000. For 5 cows — the Duchess strain — $158,000 were paid — all showing the faith of the purchasers in the permanence of the improved stock.

For some years Prof. Brewer has been investigating this subject and seeking for proof of the alleged tendency to reversion. The inquiry only covered "*thoroughbreds*," and not "grades" nor "mongrels." To carefully worded inquiries in writing, following upon every report of such "reversion," Prof. Brewer has received very numerous replies, and they are unanimously in the negative. This is certainly remarkable, following upon the confident assertions that animals so frequently exhibited the alleged tendency. The inquiries were pushed in the specific localities where the reversion was said to have occurred; the questions have been put to a large number of stock-breeders, and finally have been made by means of a printed circular. But the result was always the same, except that a smile of incredulity extended over the faces of some stock breeders when such inquiries were put to them, and they feared they were to be made the victims of a "sell." No instances of the alleged "reversion" having been authenticated in Prof. Brewer's experience, he asks the Association to aid in exposing and refuting the pernicious notion.

Deep Sea Explorations. — In a letter written by Professor Wyville Thompson, in charge of the "Challenger" Expedition, we have some account of the dredgings at great depths in the Antarctic Ocean. After leaving the Cape of Good Hope, several

dredgings were taken a little to the southward, at depths from 100 to 150 fathoms. Animal life was very abundant, and it was found that the general character of the fauna was very similar to that of the North Atlantic — many of the species even being identical with those on the coasts of Great Britain and Norway. Between Prince Edward's Island and the Crozets they trawled in 1,375 and 1600 fathoms, and many new forms, including two stalked crinoids and some deep-sea sponges and sea-urchins, occurred. Off Kerguelen Island, a fine sponge (Rossella) — probably the *Rossella antarctica* — originally dredged by Sir James C. Ross, near the ice-barrier, was obtained. At their most southerly station — lat. 65° 42′ south, long. 79° 49′ east — the trawl brought up from a depth of 1,675 fathoms a considerable number of sponges and other deep-sea forms. Dredgings with similar results were made in 1,800 and 1,900 fathoms. Again at a depth of 2,600 fathoms Holothurians were abundant, with several star-fishes and Actiniæ and an "elegant little Brachiopod." By using the towing net from the surface as deep down as 150 fathoms, Mr. Murray, one of the party, infers "that the bulk of the material of the bottom in deep water is in all cases derived from the surface."

The Chestnut-sided Warbler. — In the account of the chestnut-sided warbler (*Dendroica Pensylvanica*) in vol. I of "North American Birds," Dr. Brewer states that "it is not known to breed farther south than Massachusetts." On May 19, 1871, I shot a female of this bird off a nest of four eggs, at White Sulphur Springs, West Virginia. This locality is about 2000 feet above the sea and somewhat below lat. 38. The nest was eighteen inches above ground in a small thorn bush in a swampy thicket. With the exception of being slightly smaller, and having the chestnut side streak more faintly developed this bird does not appreciably differ from specimens I have from Canada. — Arthur C. Stark, *Hillstead, Torquay, England, Oct.* 29, 1874.

Embryology of the Brachiopods. — Kowalevsky has published a fully illustrated paper on this subject in the "Memoires" of the Academy of Science at St. Petersburg. It gives an account of the embryology of Argiope and other genera, and is fully corroborative of the studies of Prof. Morse and his opinion that the Brachiopods are closely allied to the Chætopod worms. A number of interesting sections of the embryo are figured. At one stage

the larva would easily be mistaken for that of a worm. On another occasion he writes that "it was while fresh from the impression produced on me by the views of the American scientist that I write the last portion of my general review, although I had previously arrived myself to the conclusion, based upon the homologies of the muscles and setæ, that the Brachiopods are nearly allied to the Chætopod Annelides."

METAMORPHOSES OF THE HAIR WORM.—M. Villot is publishing a monograph of the Hair Worms in the "Archives de Zoologie Experimentale." He has found the larvæ encysted in the larvæ of Chironomus, and afterwards in the mucous lining of the intestines of fishes, in September. Thus their metamorphoses have been, in conjunction with the previous labors of Grube, Leidy, and Meissner, cleared up. The larvæ are tadpole-shaped. The habits of Gordius seem quite distinct from Mermis, found living in insects.

A NEW ORDER OF HYDROZOA.—Prof. Allman publishes in "Nature" a brief account of his discovery of a French hydroid embedded in a sponge, which he describes under the name of *Stephanoscyphus mirabilis*, and regards as the type of a new order termed *Thecomedusæ*. He regards this animal as a compound hydrozoon, "whose zooids are included in cup-like receptacles resembling the hydrothecæ of the calyptoblastic hydroids; but these zooids, instead of being constructed like the hydranths of a hydroid are formed on the plan of a medusa. It has plainly very decided affinities with the Hydroida, but it is nevertheless removed from these by a distance at least as great as that which separates from them the Siphonophora."

BIRDS OF KANSAS.—Since the publication of the second edition of my catalogue of the birds of Kansas (Oct., 1872), six additional species have been observed; viz: *Colaptes Mexicanus*, *Helmitherus vermivorus*, *Dendrœca striata*, *D. maculosa*, *Larus Delawarensis* and *Podiceps auritus* var. *Californicus*.—F. H. SNOW.

OSTRICH BREEDING.—The success which has attended the ostrich-breeding farms in South Africa has induced some French gentlemen to endeavor to imitate the system in Algeria, and African birds have also been sent to La Plata and other countries in South America, where it is hoped they may take the place of the native birds, which are inferior in quality to the African ostrich. Generally speaking, the system on which ostrich farms are conducted is

as follows:—The birds kept for breeding purposes, about three years old, are placed in separate paddocks, in pairs, and their eggs are either hatched in the natural way or placed in incubators prepared for the purpose. By this means a larger proportion of eggs is hatched. The young birds are fed on grass, lucern, and other vegetable matters, and are sheltered at night. Each pair of birds will produce about twenty chickens, which may be plucked when they are about eighteen months old, before which time the feathers are not of much value. The price of good ostrich feathers, wholesale, is about 40 *l.* per pound weight. If the birds are well kept, and have plenty of exercise and food, their feathers are of good quality; but the plumage of wild birds is considered superior to that of inferior tame ones. The value of each year's plucking from the young birds is about 7 *l.*, and of the birds themselves six months old is 30 *l.* to 35 *l.* The breeding birds are worth 125 *l.* per pair.—*Nature.*

Case of a Dog Nursing a Kitten.—Mr. John Downing, residing at No. 27 Morgan Street, has a female dog of some breed of setter, which has not been pregnant for upwards of three years. At her last pregnancy she gave birth to six pups, of which one only was allowed to survive; this one was continued with her only six months. Since then she has been entirely alone, and spends her days in a close yard and her nights in a house.

She has always been averse to the society of cats, repelling all their advances towards friendship. About two months ago the family procured a very small kitten, and the dog was soon observed to keep it near her, and rather tagged it around. About four weeks ago the dog was observed to be nursing the kitten, and has steadily given it milk ever since. The four posterior mammæ are a little tumefied, but the forward ones are as flat as in an unimpregnated puppy. Upon gentle pressure, an abundant flow of milk readily shows itself, and what seems remarkable, from all the teats alike. The kitten thrives vigorously, which seems to demonstrate that the milk is a normal secretion. As soon as the kitten approaches the dog, she lies down and offers herself to the kitten as to her own offspring, and the kitten purrs itself to sleep while nursing, apparently regarding its adopted mother as a perfectly normal substitute for its natural nurse.—F. H. Williams, 70 *Mulberry St., Hartford, Oct.* 26, 1874.

ANTHROPOLOGY.

THE EARTHWORKS OF "FORT ANCIENT."—On the 16th of June, 1869, I found myself in the neighborhood of the famous "Fort Ancient," on the little Miami River, some four miles above the town of Morrow in Warren County, Ohio; and as a day's leisure was left me I determined to visit these interesting remains of the prehistoric tribes of America. The following notes additional to those made by previous visitors may be of interest. With a tracing in my hand of the survey of Dr. Locke, as given in the first volume of the Smithsonian Contributions, I ascended the road leading eastward from the railroad station and entered the fortifications at a point which is said to have been an original outlet, but which has been so enlarged for the use of the present roadway that its original facing is now gone. The excavation thus made has revealed a section which shows that the earthwork was originally begun by building an exterior retaining wall, two to four feet high, of flat stones.

The outer parapet of the fort was now followed by me with great faithfulness entirely around the enclosure. Descent was made into each and every ravine, and the whole examined as carefully as was possible for one person to do in about five hours; it will be remembered that twelve persons were occupied two days in making the survey published by Dr. Locke.

The principal new features that I noted may be summed up as follows:

1. The retaining wall above mentioned.

2. Certain outlets, twelve in number, are not for drainage purposes. On the contrary, they invariably have on the inside a raised pathway crossing the interior ditches and connecting the outlet with the interior of the fort, and on the other hand they open exteriorly not into a ravine, but upon the crests of ridges dividing two ravines.

3. The breaks in the continuity of the parapet may therefore be divided into two classes. First, the just mentioned actual gateways opening out upon crests of ridges, and second, sluices for drainage—whence many of the small streams take their rise.

The engraving given by Dr. Locke, therefore needs correction in these particulars.

Of the seventy breaks in the parapet not more than twenty were used as gateways.

4. The gateways are distinguished by having their floors elevated above the natural surface of the ground both outside and inside of the parapet; they were also probably all faced and paved with stone, as remains of these stone facings are often seen, and the facing and paving of one of the gateways are still almost perfectly preserved.

5. At one point there are plain traces of a stone pathway (probably originally stone steps) leading for a long distance from a gateway down the crest of the ridge towards the brook that empties into the little Miami.

6. The ravines of the western side of the northern half of the fortification had been so filled with brush that it was impossible for me to examine them as thoroughly as was desirable, or to visit the well near by.

7. The entire interior of the northern half of the fort is now under cultivation, and the plough has revealed two large piles of stones at one spot.

8. There are but two instances of recent gullies cut through the embankments, and the ravines are now in very nearly the same condition as when the work was built. Only in four places are the original ravines perceptibly deeper than when the work was deserted.

9. Many holes have been dug by treasure-seekers, especially by a person from Lebanon, who is continually resorting hither with a hazel rod in his hand.

10. Two mounds are to be found in the woods on the south and east of the fortification as reported to me by the farmer living in the neighboring house on the Chillicothe road, but I had not time to hunt for them.

11. An oak tree on the northern face of the embankment was recently cut down having five hundred rings counted by Hon. E. D. Mansfield, in 1855.

12. No stone implements were found nor any traces of them.

13. The general impression that one must receive from the study of this remarkable earthwork is that it was once the defence of a walled town,—that it was not a hasty construction, nor soon abandoned, but was occupied for a long period. The central neck is so well guarded at both its ends, as well as its sides, that it would

seem as though the inhabitants had provided for a retreat in case of the capture of either half of the town. The southern half is far better defended, naturally, by ravines and steep inclines, and artificially by its double walls, so that this may well have been the first home of the people who, afterwards, extended the limits of their walled town northwards. The weakest portion of the fortress is on its northeastern side where the artificial embankments are unusually high and steep, and where the main gateway opens out upon a broad level field on which is erected the mysterious enclosure whose outlines are given by Locke. The mound at the farther end of this enclosure I should say might well have served as a watch-tower either for the besieged or the besiegers,—its parallel walls affording means of escape and of defence. It is not clear to me but that the forest may have been allowed to stand both within and without the fort, even during its occupation, the trees being indeed an advantage both as protection against sun and wind, and as affording great help in actual combat.—CLEVELAND ABBE.

[Being unable to reproduce Mr. Abbe's drawings we have omitted his letters of reference.—EDS.]

MICROSCOPY.

DISTRIBUTION OF THE RHIZOPODS.—At a meeting of the Academy of Natural Sciences of Philadelphia Prof. Leidy remarked that while it was exceptional to find the same species of the higher sub-kingdoms in the different parts of the world, it appeared to be the rule that most species of Protozoa were found everywhere under the same conditions. A large number of our fresh-water forms he had recognized as the same as those described by European authors. A less number of species are probably peculiar to every region. Among our fresh-water Rhizopods he had observed not only the genera Amœba, Arcella, Diffugia, Euglypha, Trinema, Lagynis, Actinophrys, etc., but also most of the species of these as indicated by European naturalists. It is an interesting question whether our fresh-water Protozoa have reached us from the same sources as those of Europe and other remote countries. If derived from the same sources they were probably infused in the waters of the different continents at an early age when the latter were not separated by ocean barriers. If thus early infused we have a remarkable instance of a multitude of specific forms retaining their identity through a long period of time. Such a view might appear to oppose the doctrine of evolution, but not

justly so, for the simplest forms would be the slowest or least likely to vary, while the most complex, from their extended relationships, would be most liable to variation. Perhaps, however, the simplest forms of life, of the same species, may have originated independently of one another, not only in different places, but also at different times, and may yet continue to do so. While the highest forms of life may have been slowly evolved from the simplest forms of the remotest age, equally simple forms may have started into existence at all times down to the present period. From the later original forms new ones may have been evolved to speed towards the same goal as those which preceded them.

NOTES.

In an article in the "North American Review" entitled "Exact Science in America," Mr. Simon Newcomb concludes that "we are a generation behind the age in nearly every branch of exact science." He attributes this to the want of effective organization and incentive rather than to our lack of zeal in developing the material resources of the country. This statement also applies in a measure to biological science. How far the state and national geological and biological surveys have served, instead of any more direct and effective means of organizing scientific efforts, would be an interesting inquiry. As it is, the national and several state geological surveys have been almost the only means of educating students in science, of bringing to a focus the labors of scattered scientists, and of placing before the people the results of the examinations with more or less care of the geology and natural productions of our states and territories. Look, for example, at the Geological Survey of the state of New York. By the wisdom and liberality of the legislature of that state, a series of volumes on the geology, agriculture, palæontology, zoology and botany of that commonwealth have been issued, which have altogether immensely advanced these sciences in this country and assured European naturalists that in native ability and power of observation and of producing useful results from abstruse knowledge the American is not behind his trans-Atlantic brother in science. That survey also called in the aid of some eminent European naturalists, established a large museum, one of the finest in the world, and a body of assistants who have formed a coterie or school of observers, which have done and are doing much to elevate the standard

of pure science in our country. The Coast Survey in like manner, and the survey of the Territories, have built up centres of science and gathered at Washington a number of scientists, which have made that city second to no other scientific centre in the United States, and developed the energies and collected the results from observers scattered over the country. The direct influence of surveys, geodetic, geographical, and geological, in developing our science is most apparent. Certainly our colleges and universities thus far have not proved to be centres for the advancement of science; they tend to act rather as conservators of knowledge. Exception should of course be made for Harvard and Yale.

It is not to be overlooked that some of the most talented observers are not connected with any college or survey, and science has been largely indebted to isolated students for her most valuable discoveries. But it is to state and government surveys that America is on the whole most indebted for her present scientific position; in other words to *grants of money and incentives to work from the people.* It is for this reason that the proposal on the part of a number of the scientific citizens of the state of Massachusetts, who lately had a hearing before the State Committee on Education in regard to a re-survey of the topography, geology and biology of the state, will we hope, meet with favorable action on the part of the legislature this winter. By the annual appropriation of $20,000 for a period of fifteen years, a careful, elaborate and most useful survey of that small state can be made. No survey has been made for nearly forty years. The value of the brief and incomplete reports published by the state, about forty years since, *i. e.* the botanical works of Mr. G. B. Emerson, Gould's "Invertebrates of Massachusetts," Storer's "Fishes of Massachusetts, and Harris' "Treatise on the Injurious Insects of the State," —the value of these, not to speak of the other excellent reports, as educational works, in making students of science, in assisting state teachers and in aiding farmers and gardeners in combating injurious insects, cannot be overestimated.

So valuable have these works been considered, that the state reprinted those of Drs. Gould and Harris at a cost of $20,000. Every motive of state pride and economy calls for a thorough and final survey of the state, with reports on all departments of science, botanical and zoological as well as geological and topographical. Several other states, as Pennsylvania, Kentucky, North

Carolina and others, are making re-surveys. Such a survey, comprehensive and thorough, embracing biology as well as physical geography and geology, can be done much cheaper than many may think. The work can be accomplished as in the past, largely by naturalists and students without pay. Many monographs on groups of animals and plants, private geological explorations and the coast survey triangulations already made can be worked in without cost. The final reports can be sold at cost, and thus repay the original outlay in printing them. Those of some states have already more than repaid the cost of publication. It is to be hoped that the biological side of the survey will be fully attended to. There is a pressing need among our agriculturists of a knowledge of our parasitic plants and injurious animals.

The amount of produce annually raised in the United States is $2,500,000,000. It is estimated that we lose one-fifth of this amount, or $500,000,000, from the attacks of injurious plants and animals. Of this amount certainly one-tenth, or $50,000,000 could be saved with a proper knowledge on the part of our agriculturists of the forms and habits of the injurious species. In one year it is said that in the Eastern counties of Massachusetts the farmers lost $250,000 worth of grass from the attacks of the army worm. In 1871, in Essex County alone, $10,000 worth of onions were destroyed by a minute insect; a loss that a slight knowledge might readily have prevented. We need state aid in affording the means of importing and raising certain parasitic insects which prey on the injurious forms. In a money point of view the natural history side of the proposed survey is fully as important as the geological or topographical.

Moreover the biological department of the survey could be carried on at a slight expense compared with the topographical and geological; and the reports, if properly illustrated and containing notes on the modes of living of injurious plants and animals, would, we doubt not, fully repay the original cost of printing.

The attempt to colonize the bay of San Francisco with lobsters seems to have met with success. Of a hundred large female lobsters with eggs sent in June, 1873, from the eastern states, seven survived, and were placed in the bay. Fifteen or twenty young were lately caught by a Chinese fisherman while casting his net for shrimp.

A RECORD of works on geology, mineralogy and paleontology, British and foreign, will be issued by the middle of 1875, to contain short abstracts or notices of papers, books and maps published in 1874. The first volume will contain from 200 to 300 pages. Price 10s., 6d. Subscriptions should be sent to the Editor of "Nature," care of Macmillan & Co., New York.

A SOCIETY of Natural Science has lately been organized in Poughkeepsie, N. Y., with the following officers, — President, C. Van Brunt; Vice President, W. G. Stevenson, M. D.; Secretary, W. R. Gerard; Treasurer, C. F. Arnold.

DR. J. H. SLACK, of New Jersey, well known as a naturalist and pisciculturist, died August 24. He wrote on Egyptian antiquities and the mammals.

FRANCIS WALKER, the entomologist, died Oct. 5.

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Philosophical Transactions of the Royal Society of London. 1872. Vol. 162. Part ii. pp. 241-501. and 1873. Vol. 163. Parts i and ii. pp. 662. Illustrated. 4to.

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List of Fellows of the Royal Society for 1872 and 1873. pp. 32 and 32 4to.

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Memoires de l'Academie de Dijon. Dijon, 1871. 2e Serie. Tome xvi, 1870. pp. 367. 8vo. 3e Serie, Tome Ier, 1871, 1873. pp. 112.

Bulletin Mensuel de la Societe d'Acclimatation. Paris. 3e Serie, Tome i, 5, 6. Mai, Juin, 1874. pp. 257-432. 8vo.

Oversigt over det Kongelige Danske Videnskabernes Selskabs. Copenhagen, 1873. No. 3, 1874. No. i. 8vo.

Berliner Entomologische Zeitschrift. Berlin, 1874. Tafel i. Seite 1-8, 241-448. With illustration. 8vo.

Verhandlungen der Naturforschenden Gesellschaft. Basel, 1874. Sechster theil. Erstes Heft. Illustrated. pp. 215. 8vo.

Transactions of the Edinburgh Geological Society, 1874. Vol. ii. Part iii. With plates. pp. 247-434. 8vo.

Report of Progress for 1872-73. Geological Survey of Canada. Dawson Brothers, Publisher, Montreal, 1873. With plates. pp. 500. 8vo.

Zeitschrift fur Gesammten Naturwissenschaften. Berlin, 8874. Bd. ix. With cuts. pp. 568. 8vo.

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Report upon Ornithological Specimens. By Dr. H. C. Yarrow. 1871, 72, 73. Engineer Department, U. S. Army, Washington, D. C. pp. 148. 8vo.

Catalogue of Plants. By S. Watson, Engineer Department of U. S. A., Washington, D. C. pp. 62. 8vo.

The Ornamental and Useful Plants of Maine. By F. Lamson Scribner, Augusta, 1875. With plates. pp. 85, 8vo.

Twenty-Sixth Annual Report on the New York State Museum of Natural History. Albany, 1874. With cuts. pp. 192. 8vo.

Description of a New Species of Calocampa. By J. A. Lintner, Albany. 1874. pp. 2. 8vo.

On the occurrence of Tupaia Elliote, Waterhouse, in the Satpeura Hills, Central Provinces. By V. Ball, 1874.

On an ancient Perforated Stone found in the Satpura Hills. By V. Ball. Illustrated. pp. 3. 8vo.

On Habits of Some American Birds. By Thos. G. Gentry, 1874. pp. 96-110. 8vo.

The Monthly Microscopical Journal. London, 1874. No. lxxi. pp. 209-260. 8vo.

Remarks on North American Noctuidæ with description of New Species. By Aug. R. Grote. September, 1874. pp. 10, 8vo. Received Nov. 14, 1874.

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